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SCHOOL SCIENCE AND MATHEMATICS

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MANAGING A SCIENCE CLUB.[1]

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220 West 120th Street, New York City

Educational thought and investigation of the last ten or fifteen years have been focusing the attention of teachers, supervisors, educators, and the thinking public upon certain educative forces that exist quite apart from the activities of the schoolroom. These forces are sometimes so vital and so important in shaping the life of the individual that the failure of the educational system properly to guide and control them has brought upon it a considerable portion of the criticism of recent years. Developments in educational philosophy and psychology have been very emphatic in pointing out that what our pupils do during every hour of the twenty-four in the day—and of every day in the year—is a factor making for education and therefore a legitimate consideration for the school and teacher. Thus, we have begun to investigate such questions as home-study, play, and nutrition. We have gone into the home and made recommendations to parents in matters which have hitherto been looked upon as belonging only to mother and father. We have begun to lay stress upon student organizations of all sorts, seeking in them value in citizenship and habit formation. Clubcraft, scoutcraft, and camping have become pertinent considerations for the educator and, what is more important, for the teacher in the classroom. And, as might be expected, this newer element is having its influence upon our schools, their organization, curricula, courses of study, and methods of instruction. The concept that the school is not a place where we prepare for a life that is to come, but is an integral part of life itself, must necessarily and in a very intimate way, relate school procedures with the vital factors of life.

[1]Paper read before Science Section of the N. E. A. Meetings in Boston, July 5, 1922

In a sense, we are preparing our pupils for a future life in the most effective way when we teach them to live better their present lives. From considerations such as these, extra-curricular activities have been deriving greater importance. Eventually, the line of demarcation between the two phases of activity should fade completely. The school day may start at 9 and end at 3; but its influence will function at all times. And in turn, methods of work, content, and organization within the four walls of the schoolroom should take their quality and their inspiration from the wellsprings of enthusiasm so common to after-school activity.

Needless to say, we are as yet far from so ideal a development. To the pupil, out-of-school time has always been and still is the period of freedom par excellence. We have perhaps progressed beyond the point where he thinks of the schoolroom as an abode of horrors, of the teacher as an ogre, and of books as instruments of torture; but too often his real life is still essentially distinct from the school. His greatest activity and his greatest enthusiasm still center around the extra-curricular, where are to be found problems of his own choosing and ideas born of his own inner urgings.

And society is filled with individuals who look back upon these two phases of their past lives with two quite distinct attitudes: with censure, criticism, and unpleasantness for the one; and with glowing recollections of time profitably spent for the other. It is a very wide spread reflection upon American college education that it is essentially an extra-curricular training. In some colleges it is frequently a matter of disrepute to have devoted much time to studies. The same condition holds for the high school and, in a different sense, even for the elementary school. The man of sixty who reviews his life and concludes that his real education was what he got while in contact with the world of actual experience is often paralleled by the high school or college student who regards as his real schooling his experiences of out-of-school life. "He has nine months in which to get his schooling and three months in which to gain an education."

From every point of view possible, extra-curricular activities loom up as immense factors of educational importance. In the field of science there has always existed a body of materials and experiences that were essentially tied up with life out of school. Before the great industrial changes which brought to civilization the "factory," and which herded our masses into congested

cities, the home was a center of industrial, social, and intellectual activity. In this activity were found a stimulus and an opportunity for experiences of a physical, mechanical, and manipulatory nature. This stimulus, existing quite apart from the systematic education of sixty or seventy years ago, nevertheless made one of the largest contributions to the intellectual development of the individual of that day. As modern industrialism continued in its growth, the home ceased to function in the old sense. Education became more and more "curricular" and systematic, "squeezing the educational juice" out of the home.

In the last ten or fifteen years there has come into existence a substitute for this lack of manipulatory and sense-experience in the modern city home. A mass of science play-materials has invaded the apartment house. The boy spends large portions of his time on them; and the parent often stints himself in order that his boy may have them. In the matter of time expended, effort exerted, interest aroused and thought provoked, these materials and activities compare most favorably with what the same boys do *in school.*

The science teacher, in particular, is affected by this activity which goes on outside of his classroom. Sometimes he uses it for his illustrations, sometimes he makes use of the toy apparatus, sometimes he cautions against certain undertakings, and sometimes he opposes an activity and rules against its worthwhileness. But more frequently, there is but one effective way of organizing and guiding such intense interests as the one in radio communication, for example, or in experiments with chemistry outfits. and that is, to create a Radio Club or a Chemist Club, etc.

More and more each year, private commercial enterprise is stimulating and feeding the inherent interest of the boy in the mechanical and other manipulatory devices. Instead of waiting till high school or college years before meeting at first hand and in a crystallized form some of the manifestations of the laws and principles of physics and chemistry, the boy of *ten* now possesses such toys as

"Experiments with light"
"Experiments with magnetism"
"Experiments with water and air"
"Chemical experiments"
"Experiments with Sound"
"Meccano and Erector"
"Experiments with Electricity"

and even such toys as "The Mineralogy Set," "The Surveyor's Outfit," and "The Glass-Blowing" and "Soldering Outfits."

It is a most important fact that the period in a boy's life which might be designated as the "toy age" corresponds very closely with the so-called "gang age." The social instinct which begins to show itself to a marked degree during adolescence finds outlets in one way or another. The toy manufacturers, vieing with one another for the trade of their little customers, have been organizing elaborate clubs and circles of boy scientists and experimenters. The Gilbert Institute of Engineering, the Chemcraft Chemist Club of America, or the Meccano Guild are each vast science clubs more or less organized, more or less effective, more or less in competition with each other and each with a program of activities, prizes, honors, diplomas (and even degrees) that make use of an inherent instinct, essentially for their own gain. Without minimizing the very real educational value of these toys and the "institutes" which the manufacturers have woven around them, it does seem that so genuine and keen an interest should legitimately fall to the teacher for development, instead of serving exclusively for advertising propaganda of a very excellent kind.

The club in its relation to after-school activities in science holds forth great promise as an instrument for education. But unless the average teacher be acquainted with the many pitfalls that club-leading presents to the novice, even the most enthusiastic of us will suffer severe discouragement. And so, to be of some practical aid to science teachers who recognize the value of and are inclined to try their hand at managing a Science Club, the writer wishes to present his experiences with three matters involved in such an undertaking:

(a) The nature or character of the club.
(b) Its organization.
(c) Its program of activities.

First, as to the kind of a science club one can manage successfully with pupils of Junior High School age.

(a) *TYPES OF SCIENCE CLUBS:*

Almost every wide-awake teacher of science has in one form or another attempted to enhance the interest in his subject by organizing after-school special study groups of some sort. Educational magazines abound in descriptions of such groups and their methods. In 90 per cent. of the cases that the writer has read or known about, these groups or clubs tied themselves to one very specialized interest. Sometimes it is a Radio Club. Sometimes it is a Field Trip Club, or a Photography Club or an Aero Club, or an Automobile Club, or a Chemistry Club; or a

club for the study of some other special subject. The experience of these specialized clubs is very often short-lived. The chief sources of difficulty are two: First, the prime movers in the group lose their influence on the majority because they advance so rapidly that the rest feel hopelessly outclassed. Second, the progress of the very few leaders in the club soon exhausts the knowledge, ability and equipment of the average teacher of science. Where the latter is not the case, the group continues; but it becomes very limited and select, establishing an "aristocracy of scientists." This, of course, is of immense value to the "aristocrats," but it doesn't at all utilize the possibilities along these lines that the mass of individuals possess.

In contrast to this type of club, we have the General Science Club, which adopts no special hobby for its exclusive program. Obviously, it is this type of club to which we must look for extensive educational values and in the organization and conduct of which we can find suggestion of a "boy science movement," or for the popularization of a real science interest, etc.

(*b*) *THE ORGANIZATION OF THE CLUB.*

The club each year adopts a constitution. It is not exactly within the sphere of this paper to dwell upon the technical point of constitution-framing, but a good deal is dependent upon the adoption of a document that will actually function. The constitution must be brief, simple and both written and adopted by the boys. At the first meeting of the club, it is well to point out the need for a set of rules, and then with the aid of the group to organize the material that that particular group wishes to put into its constitution, in the form of questions, thus:

1. What shall be the aim and purpose of our Science Club?
2. What shall be its name?
3. Membership:
   (a) Who can become a member?
   (b) What must a boy do to become a member?
4. Meetings:
   (a) When shall they be held?
   (b) Where?
   (c) How often?
   (d) Who shall call for special meetings?
5. Money:
   (a) Shall we pay dues?
   (b) How much?
   (c) Can we levy taxes?
   (d) How? How much?
   (e) For what shall the money be used?
6. Expelling members:
   (a) For what reason or reasons?
7. The business program?
   (a) How long shall it be?

(b) What shall be the procedure?

8. The science program:
   (a) How many different activities shall the club have?
   (b) Who shall decide upon and arrange these programs?
9. Officers:
   (a) When shall elections take place?
   (b) How often?
   (c) What officers shall we have?
   (d) What shall be the duties of each officer?
   (e) How can an officer be impeached?
   (f) How can an officer resign?
   (g) Shall officers filling positions left vacant be appointed or elected? And how?
10. Any other regulations you think it important to put into the constitution.

The outline decided upon, a committee is appointed to present answers to the questions raised by the outline. In the meantime, a set of temporary officers is elected. At the next meeting the constitution is discussed, altered and finally adopted by a majority vote. It is typewritten and pasted into the secretary's book. The chief value of the constitution is to create an "atmosphere." Often this procedure is the first of its kind that the boy has ever experienced. It appeals to him and makes for solidarity of the group.

The officers of the club usually consist of a president, a vice-president, a secretary, a treasurer, a sergeant-at-arms, a librarian, and two scouts. Their duties are those that usually devolve upon such officials. The sergeant-at-arms is custodian of apparatus—arranges seats, collects and distributes materials and in general maintains order. The librarian is in charge of all books, pamphlets, magazine articles and pictures owned by or contributed to the club. He organizes a system by which members can draw books, etc., from the club library. The scouts discover and investigate interesting places to which the club can make excursions. The club, however, has the power of decision as to whether these excursions shall be arranged. The president and the director arrange the science program for each week and the vice-president acts as recorder of the demonstration programs.

Dues are usually five cents a week and occasionally a tax of not more than ten cents is levied in order to purchase a special piece of apparatus or the club insignia or to pay for the awards and prizes.

A business meeting of no more than fifteen minutes precedes the main program, during which time the members act on the reports of the scouts, the librarian, or any committee which may have been appointed, and passes on the applications for membership of new applicants.

Though qualification for membership varies with any particular group, it is usual to expect every member to prove his right to join by showing an ability to earn fifteen points of merit. (The Point System is described below.) To remain a member in good standing it behooves a boy also to score at least fifteen points each month, in addition to his initiation points.

Sometimes when the club grows too large for efficient work, as in the case of the Speyer Science Club, it becomes necessary to recognize two types of membership. Grade A is the very active boys who give up practically all of the extra-curricular time to science club activities. Grade B is the boys who, because of the demands made upon them by athletics, other clubs, and home chores, cannot assume an equal share of the club's activities with boys of Grade A. They come to the meetings, are very much interested in its doings, and participate to the extent of their ability. Sufficient admission requirements and membership standards are imposed to avoid a floating membership.

The success of the club is, of course, more dependent upon the director than upon any other one factor. The director should take no active part during meetings, except where it is necessary to carry the boys over what is to them an insurmountable difficulty. As was mentioned before, the director and the president confer upon and arrange each week's program. In all matters he should act as advisor. His frame of mind should be that of a man behind the scenes, who, having set the stage, stands by, watching the performance, ever ready to step into a situation and set things right. The ability to do this properly comes with practice. It does not demand exceptional ability or personality. The writer has often absented himself from meetings, arranging for a student-teacher to take his place. The most necessary characteristics that the leader should possess is a familiarity with the interests of the boy, a well-organized program of activity, and ability to handle tools and to improvise apparatus, and a good knowledge of practical science. In other words, the qualities that go to make a good teacher of science are also essential for science club leadership. In some ways it is even easier to lead a club than to teach. The club leader can with greater safety confess ignorance on some subjects and work together with his boys in the solution of a problem. A classroom situation is usually not as well adapted to such a procedure.

(*c*) *THE PROGRAM OF ACTIVITIES.*

Next to efficient leadership, the successful club depends upon

its program. In a sense, a well-organized program can make up for inexperience or poor leadership. There are in all five types of activities that merit description.

1. Lectures.

Boys like to imitate. They like to regard themselves a body of great scientists who are assembled to listen to and pass on great discoveries and inventions. With great seriousness they will introduce their speakers and sit back to listen critically to what is being presented. These lectures may be given by their own members, by former members who return with newer and richer experiences, or by adults. It is not very difficult to get science teachers, professors of science, or engineers to come before the club. They enjoy talking to youngsters. Occasionally the director presents a talk or a demonstration. More often the members themselves give these lectures, and stand the fire of dozens of questions which usually wind up their talks.

2. The Trip.

The excursion is now a recognized form of instruction. As an activity of the club it presents quite a different problem. Excursions too often become a pleasant means of killing time. As a curricular activity, it is subject to several difficulties: It cannot always be arranged to meet a classroom need at a crucial time. The teacher is handicapped by discipline problems, by limited time, by lack of information of the plant or factory visited. The engineer or person in charge is very seldom a teacher or one who can patiently answer the questions that boys will ask. The teacher must be ever conscious of a definite teaching unit and provide for reactions when the trip is over, which makes the class too conscious of the fact that they are being taught. In the club, the boys must decide by a two-thirds vote whether to make the trip or not, and the dissenting one-third need not come. The result is an attitude which automatically provides for reactions that make the time spent educationally valuable. Those who have come to feel that excursions are always interesting and productive of enthusiasm, will surely revise their opinions after some experience with boys who are permitted to arrange their own excursions. The writer does not wish to go on record as being opposed to this means of instruction. The contrary is true. He does wish to point out the elements which make the trip successful. When the scouts interview the manager of a plant, they assume a responsibility which insures good order and respect for the company's property.

Also, they seem to possess a strange faculty for discovering men who can talk to boys. Then, too, the club leader plays the role of visitor with the boys. And finally, the original interest which motivated the trip calls forth lasting reactions that not only supply a fund of information but inspire thought. It is not at all uncommon to find a good many boys making a second and a third trip to the same plant, on their own hook, in order to learn more about some machine or process. It is to be noted that one of the secretary's duties is to write up the excursion in full detail. This account is read at the next meeting. No such account has ever gone uncorrected or unsupplemented. Often the compositions throughout the school for that particular month will abound in descriptions of the excursion.

3. School Assemblies, Exhibitions, Bazaars, etc.

The social life of any school is highly important. It produces that much-desired thing, "school spirit." There is no surer way for a teacher and his subject to become popular and respected than by entering into the social activity of the school. One of the activities of the Science Club is to arrange periodically for events to which the school at large can be invited. This has in the past taken many forms. Sometimes the school assembly period is devoted to an exhibition of "science magic" or a demonstration of some boy inventions or the presenting of a playlet that has a science plot, etc. One or two experiences of this sort may be valuable in pointing out what science club leaders may expect in this phase of activity.

A play was to be presented at a Saturday afternoon gathering of boys, girls, teachers, and parents. The plot, written by a boy, was briefly as follows: The Science Club sergeant-at-arms catches a small fellow tampering with the wireless aerials belonging to the club. He hauls him before a meeting of the club, where he is put on trial. It develops that the culprit had been urged by mere curiosity and a desire to understand what the thing was. After some very wild suggestions by members as to punishments, one boy makes a plea for the offender's life, proposing that he be permitted to join the club where he could learn all about it. His eloquence wins the club over and they then proceed to initiate him "scientifically" into the club; after which the president ties the club insignia around his arm. When the "drama" commenced some of the leading actors became stage struck to the extent of forgetting their lines. Fortunately, the movement of the plot, being of their own origin, was very

clear in their minds. First one and then another they all abandoned their memorized lines and rose to the occasion spontaneously. In parts it was crude, but months of rehearsing could not have produced the spirit and genuineness of the acting. It was a great success.

On another occasion the club held a bazaar to raise money for the Red Cross. Samples of the club work were exhibited and people were urged to leave orders for any scientific toy that struck their fancy. The boys were carried away by their enthusiasm and obtained a great many orders for which they collected in advance. At the meeting that followed, they were confronted with the dilemma of either refunding some of the money or working for three weeks in order to fill the orders. The lesson in responsibility was a good one. They met their obligations.

In many other ways the Science Club can become a leader in the school's activities. The school newspaper, the school library, and certain parts of the school plant can all be made to function in the club program.

4. The Work Period.

About every other week it is well to spend part or all of the program in actual work with tools and apparatus. This at once makes essential that there be not more than twelve or fifteen boys at a time. Ordinarily the work period can come once a week, the boys taking their turn in this activity. The purpose of this period is to give them an opportunity to try out their ideas and to experiment with their toys. During the demonstration programs to be described later, there are many things presented that stimulate them to "try out" and to "invent." The periods are designed to give outlet for these stimuli, and present a golden opportunity to direct a boy's thoughts into the proper channels. "Wild-cat" schemes can be quickly discouraged; information can be supplied; proper books put in his way, and in many other ways the boy can be helped to develop in scientific concepts and methods.

5. The Demonstration Program.

This is the most popular activity of the club next to the work period. The demonstrations center around a system of awards known as the Point System which is presented here in full. Each boy receives a copy.

REQUIREMENTS FOR THE PRIZE OFFERED BY THE HORACE MANN SCIENCE CLUB.

(250 points which will be awarded according to the following list)

	Points
1. For constructing a piece of apparatus or toy	10
2. For demonstrating a piece of apparatus or toy	10
3. For performing an experiment	10
4. For demonstrating a new Meccano or Erector construction	10
5. For demonstrating and explaining a Chemcraft experiment	10
6. For discovering, demonstrating and explaining a new Chemcraft experiment	15
7. For demonstrating and explaining a construction or experiment with an Electrical Set	10
8. For demonstrating and explaining a new Electrical Set construction or experiment	15
9. For making a great discovery or invention (so recognized by the club)	25 to 50
10. For proposing an original idea in science	1
11. For working out that idea, or anyone else's idea in practice	5 to 50
12. For duplicating any of the experiments, devices, or phenomena described in any of the Popular Science Magazines	10
13. For rendering a report or lecture to the club on some important article in any of the magazines or newspapers	5
14. For keeping a well-organized Science Scrap Book. (For every 50 important magazine or newspaper articles)	10
15. For a collection of magazine diagrams and pictures on some important idea or topic in science	5
16. For entering any of the Popular Science Magazine competitions	5
17. For winning a prize	25
18. For being able to calculate the gas, water and electricity bills	5
19. For being able to regulate a clock	2
20. For being able to do simple wiring of bells and batteries	5
21. For being able to wire up a desk lamp	3
22. For being able to regulate and take care of a player piano or victrola	2
23. For being able to replace a burnt-out electric socket	5
24. For being able to run a small electric motor	5
25. For being able to run a lantern slide machine	5
26. For being able to repair a bicycle, skates, window pulleys, window shades, etc.	5
27. For being able to take good pictures	5
28. For being able to print and develop pictures	10
29. For being able to take apart and put together again a phonograph vacuum cleaner, or sewing machine	10
30. For being able to measure a person's blood pressure	5
31. For being able to measure humidity	5
32. For delivering a lecture before the club	5
33. For taking a trip to some industrial plant and reporting to the club	5
34. For reading a book on science and reporting to the club	15
35. For reading a science story and telling it to the club	5
36. For being able to explain 10 of the phenomena listed on the club list	10
37. For being able to explain 10 of the things, mechanisms or processes listed on the club list	10
38. For knowing the names of 20 great scientists	5
39. For knowing what great thing or things each is remembered for	5
40. For being able to give some important facts about the lives of 10 of them	5
41. For being an officer, scout, or librarian of the club	5
42. For helping in the Science Shop	5
43. For helping some boy in working out his project	5
44. For excellence in Shop	5
45. For excellence in class work	5

When a boy wishes to claim points he fills out a slip of paper which he drops into the Program Box. The day before the meeting, the president takes out all these applications for numbers on

the program and brings them to the director. Together they look them over, arranging them in the best order and making a list of equipment which will be necessary. It is understood that all special apparatus will be supplied by the demonstrators themselves, who are also expected to prepare and set up the apparatus they will need. The program consists of calling the boys up in the order arranged. Each number is followed by questions and discussion. One of the most interesting reactions that this activity produces is in connection with the presenting of so-called inventions. The inventor, after explaining and demonstrating his device must then meet a flood of questions. The originality of the work is sometimes contested; the feasibility of the scheme and its practical value criticized. He is required to test the device thoroughly and often to carry on these tests over a long period of time before he is granted the points. One of nearly one hundred "inventions" of this kind was a wiring scheme by means of which a person instead of knocking on a door could turn the knob and thus close a contact which would ring a bell. Certain features of the device were doubted by the members, who made the inventor install the device in his home to see how long it would stand usage. A committee was appointed to report on its practicability.

The club minutes are crowded with such instances. There is greater difficulty in preventing the standards from becoming so rigid that they discourage activity, than there is of allowing work of poor quality to pass. It has been the writer's experience that boys can be more severe with each other than can a teacher with a boy. One of the things the director must be ever-watchful for is the doing of an injustice to some boy by his fellows. In this connection it is well for the director to keep for himself the authority of granting or not granting the points; although it should be a common practice to call for a vote where there is assurance that a judgment thus arrived at will be fair.

The pressure of the group can be utilized by the director in various ways. In the case of a boy who is interested only in the "fire-works" of his Chemcraft Outfit, the club can very easily bring about one of two results, by insisting, each time he claims points for a new experiment, on a thorough explanation of what happens. Either he becomes entirely discouraged and ceases his Chemcraft activity or he is stimulated to master the "whys" and "wherefores" of what he is doing. The minutes of the different clubs with which I have worked, show that in 67 cases of this

kind, 42 of the boys appeared at a later meeting and presented an explanation of the experiment that satisfied both the director and the boys. In the case of 32 "inventions" that were given tests of practicability, 21 were eventually perfected. Of 212 cases where boys were "stumped" by questions involving knowledge which they did not possess, 40 tried to "bluff it out," 128 asked the director for help or resorted to books, and the rest were never again heard from on those particular questions. It is not new to those who have had intimate experience with boys to say that the boys value more the respect and affection of their fellows than the reward in "points." It is also to be noted that, although a competitive system is set up in this scheme the competition is of the individual with himself; for each boy who scores 250 points for the year receives the same prize. On the average, eight or ten boys reach their goal each year.

In conclusion, it may be said that managing a successful Science Club depends upon four factors:

1. A club that is general in its interest and appeal rather than special.
2. A workable set of materials, which to a great extent can now be supplied by the toys the boys themselves possess.
3. A definite program of activities along the lines here described.
4. Intelligent leadership; the chief element of which is an ability to set the stage so that the boys will themselves carry out the program.

Furthermore, the chief role of the Science Club should be as a vehicle on which to carry promiscuous after-school activities into the schoolroom; where we may guide and control without losing that free, vital, purposeful urge to thought and to action that is so common to things our pupils do outside the classroom and often so sadly lacking in the things they do for us during school hours. And it may be that lessons taught us while running a club may reveal to us the secret of a classroom procedure that will make for greater efficiency.

NO EXEMPTION FROM PHYSICAL EXAMINATION.

Pupils of the schools of Washington State may not be exempted from physical examination at the written request of parents, since a bill amending the constitution to allow such exemption was defeated in a referendum vote. The bill had been passed by the legislature and signed by the governor, but when it went to the people it was beaten by a large majority.

At the request of housewives of Akron, Ohio, the municipal university has established a day course in homemaking for women who can not attend the extension class at night.

HOW TO CARE FOR INDIVIDUAL DIFFERENCES IN A HIGH SCHOOL PHYSICS CLASS.

University of Kansas, Lawrence, Kan.

By C. H. Watson.

Much attention has been given in recent years to the proper grading and promotion of pupils in the lower grades. Various attempts are being made to care for individual differences in classes in the first year of the high school. But practically nothing has been done along this line so far for classes in the last two years of the high school. This is especially true with respect to physics, except that in a few cases the girls and boys are separated. It is our purpose in this paper to outline a workable plan, as we see it, for providing for such differentiation.

Certain facts must, from the very outset, be kept constantly in mind. The first of these is that there *are* great individual differences between students in ordinary high school physics classes. These differences are not as great possibly as those found in the lower grades; for statistics show that in the first eight grades the widest range of differences is to be found in the fifth grade. On the assumption that with continued elimination and regrouping of pupils their differences continue to decrease throughout the twelve grades, we would naturally expect less pronounced differences in a physics class than farther down in the school grades. Furthermore, since most schools have put physics in the elective group, we find to a greater extent those electing to take the course are the ones who have a "liking" for the subject matter. Viewed from this light, it would appear on superficial examination that the need for caring for individual differences in a high school physics course at the present time is rather small. However, when we examine the grades and failures of those that have taken the subject, we find that about twenty percent, on the average, have failed. This of itself shows great lack of adjustment. Furthermore, if we examine the literature we find teachers of physics bemoaning their lack of ability to adjust the course to each member of the class. And also, if we take into account our own observation and experience, we must acknowledge the existence of great differences between individuals in the present day physics classes.

It would seem that the farther students go in school, any given difference becomes more and more pronounced. That is, differences which seemed slight in earlier grades become quite apparent in later grades. This is probably due, in part, to the neces-

sity of approaching new material more rapidly; and also to the fact that the very slow or dull pupil has been eliminated.

The second, and probably the most important, fact to keep in mind is that (theoretically at least). the aims and desired results of a study of physics are such that a large per cent of students remaining throughout the high school course should be enrolled in the course. Reference is made to the actual ultilitarian value of the proper study of this subject. Of course, the "scientific attitude" which is inculcated is of vital importance, but if no other reason is offered than the so-called "utilitarian value," that in itself (if eventuated in the course) would justify the above claim. This being true, we should be putting forth an effort to bring more students into contact with physics. This would naturally introduce even larger individual differences, which in turn would necessitate making greater provision for proper differentiation. In the further discussion, therefore, we will confine ourselves to the hypothetical (though very real in many cases) class in high school physics in the small school where it is impossible to actually divide the class, and in which it is desired to teach each year a large per cent of the Junior Class; and yet provide for the wide range of individual differences found.

Before school opens, the teacher should, with thorough deliberation, decide what are the important facts, principles, habits and skills which must be understood or acquired by all the members of the class; whether boys or girls, whether bright or dull, whether expecting to go to college or not. This will call for careful evaluation and will be rather arduous but is absolutely necessary if the subsequent work is to be done properly. Also, will be included in this list a definite number of specific applications of the principles to be made either in a general way or mathematically. The entire list will be so made up that any student must measure up with very high credit in his knowledge of the facts, understanding of principles and ability to apply the principles included in the list in order to receive a passing mark in the course. In other words, this is a list of minimum essentials and must be mastered in order to merit credit for the study of the subject.

At the same time, another list, called the "supplemental list," is compiled, of additional facts, principles and applications, the real value of which is dependent very largely upon the subsequent work of the student and also upon his tastes and abilities.

That is, the work of the "required list" must be taken and mastered by each student regardless of sex, ability or contemplated vocation, whereas the student has his choice of work to be taken from the "supplemental list." This list includes many "projects" to be carried on outside the school. It includes also, principles, facts and applications peculiar to: domestic science, the home, the shop, the farm, the engineering realm and material used in college courses—in fact, elementary physics of every kind, both in the pure and the applied science. Also, use will be made of readings, reports, class discussions and extra problem lists.

It is thus seen that by supplemental work is not meant merely work done "on the side" or at home but material which is discussed more or less in the classroom and laboratory, and which is done at the option of the student; but part of which must be done by each student that expects a grade mark higher than mere "passing." The differentiation thus provided for will take into account: amount and kinds of "factual knowledge" and varying abilities in the application of principles to concrete situations.

It may make it clearer to illustrate: From the field of mechanics I have outlined partial lists of both the required and the supplemental work. It is obvious that these are only suggestive and in no degree comprehensive.

WORK REQUIRED OF ALL PHYSICS STUDENTS TO OBTAIN CREDIT IN MECHANICS

I. You must know:

1. The meaning of the terms:
   (a) Force. (b) Work. (c) Power. (d) Horse-Power. (e) Foot-Pound. (f) Moment of Force. (g) Acceleration of Gravity. (h) Mechanical Advantage. (i) Efficiency. (j) Resultant of Two Forces.
2. The value of the:
   (a) Density of water.
   (b) Number of inches in a meter.
   (c) Acceleration of gravity in feet per sec. per sec.
   (d) Number of foot-pounds per minute in a horse-power unit.
   (e) General formula for machines ($F1xd1 = F2xd2$).
   (f) Formula for kinetic energy.
   (g) Pressure of air at sea level.

II. You must understand the following Principles and Laws:

1. Boyles Law.
2. Principle of Moments.
3. Principle of Conservation of Energy.
4. Principle of Buoyancy or Flotation.
5. Principle of the Pendulum.
6. Principle of Simple Lift Pump.

III. You must be able:

1. To work problems involving above facts and principle in:
   (a) A simple lever of teter-board type.
   (b) Simple movable pulley.
   (c) Finding density of solid when weight and volume given.
2. To read: (a) A gas meter. (b) A water meter.
3. To regulate a clock.

4. To fix an ordinary door lock.
5. To adjust tension of window shade roller.

SUPPLEMENTAL WORK IN MECHANICS.

1. Know meaning of terms: (a)Dyne. (b) Erg. (c) Gram-meter. (d) Torque. (e) Stress. (f) Siphon. (g) Poundal.
2. Know value of:
   (a) Density of air, ice, mercury and alcohol.
   (b) Number of centimeters in a foot.
   (c) Number pounds in a kilogram.
   (d) Formula for centrifugal force.
3. Understand following principles or principle involved in:
   (a) Pascal's Law.
   (b) Archimedes principle applied to gases.
   (c) Compound lever.
   (d) Force pump.
   (e) Vaccuum cleaner.
   (f) Cream Separator.
   (g) Shuttle of sewing machine.
   (h) Hooke's Law.
4. Ability to work problems involving above facts and principles. Also to work more complex problems, involving principles and facts in the required list.
5. Projects:
   (a) Make a steam engine.
   (b) Make a row boat.
   (c) Make an aeroplane.
   (d) Test a motor for its horse power.
   (e) Test milk with Babcock tester.
   (f) How to candle eggs.
   (g) Determine best type of washing-machine.
   (h) Make and explain a "cartesian diver."
   (i) Make and explain action of a windmill.
   (j) Determine velocity of rifle bullet.
   (k) Discuss "dumb waiter"—construction and uses.
   (l) Take down and put together an auto engine.
   (m) Repair bicycle.
   (n) Operate a gas engine.
   (o) Read and report on various topics.
   (p) Read and report on work of various scientists.
   (q) Determine amount of gold in a ring.

Each of the topics or projects in the supplemental list would be given a score or weight. In order for a student to get a grade above merely passing or the "D" grade, he would have to do work chosen from this list. If he did an average of, say, three points per week, his grade would be "C," providing he had measured up with the required work. If six points extra were made, a grade of "B" would be given, and for ten or more points each week a grade of "A." As long as a student could do "A" work, he would be permitted to work on any original idea or, if he preferred, he need attend the regular class sessions only certain days in the week. This would give the accelerated or bright student in physics an opportunity to follow out any special interest in the subject, or to devote more time to other studies. (I had a boy one year who ground a nine-inch reflector for a reflecting telescope outside of school hours. I gave him credit for this in the

course.) As students took up any of the projects, they would report the results to the teacher, who would decide just the number of points earned.

A plan of this character offers, it seems, an adequate and wholesome solution for the perplexing problem of teaching a mixed group of students in a physics class without doing an injustice to any student. Moreover, it is easy to administer. The required part includes that which is absolutely necessary (as a minimum) if the student expects to pursue his school work further. Consequently, a grade of "D" is given to just the completion of the required. It thus gives a meaning to the word passed. By laying out such a list, the students know what is required of them in order to succeed in the course; which is, I may say, something very rare with our present day high school subjects.

The supplemental work, on the other hand, provides for differentiation. The girl interested in home economics has opportunity to work along the line of her preference, whereas the boy who is mechanically inclined has full opportunity to pursue, without hindrance, his hobby. And at the same time each has opportunity of making an "A" grade, even though studying, to an extent, along different lines. Also, the boy on the farm or the boy in town working outside of school hours, who is doing work relating to physics, is given credit for the same.

The plan further cares for the fast and slow students. The slow student confines himself very largely to the required list and thus is not rushed too fast. The fast student, on the other hand, is given incentives for working as rapidly as possible.

The list, of course, should be tentative at first and changes made during and at the beginning of each school year. At all times the students should be encouraged to suggest desired projects, even though not listed. The writer, after using this plan in his own work for some time, feels justified in recommending it to others.

SCHOOL CREDIT FOR OUTSIDE INSTRUCTION.

Students in Denver high schools who carry work in the regular music courses offered by the school receive credit toward graduation for instruction received from private teachers also. Such outside lessons must continue for a full school year of 38 weeks, and practice must occupy at least six hours a week. The parent or guardian and the private teacher must each make a signed report for each semester on the number and duration of the lessons and the time spent in practice. Credits in music earned at school and outside may not amount to more than one unit during the year.—[School Life.

TROPICAL HURRICANES AND TYPHOONS.

By Stephen S. Visher
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Hurricanes and typhoons occasionally produce great destruction and loss of life. The famous Galveston hurricane which resulted in a loss of six thousand lives and damage to property estimated at over $30,000,000 was far surpassed by the Swatow typhoon of August, 1922, which caused over thirty thousand deaths and enormous property loss.

Fortunately such severe damage is rare but tropical cyclones are far more frequent and widespread than is commonly realized and even the lesser storms usually do considerable damage. Only by knowing of the danger and by adjusting ourselves to the storms can we avoid repeated heavy losses. The Galveston disaster led that city to protect itself from similar storms by building a great sea-wall, and by raising the level of the lower parts of the city. These efforts were so successful that a recent hurricane of even greater severity caused comparatively little damage. Likewise, partly because of the Galveston disaster, our government now maintains an efficient meteorological service throughout the West Indies so that as soon as a hurricane develops, or approaches the area from the east, its special characteristics can be studied, and warnings issued. In the Far East likewise the American government has reduced the damage from tropical hurricanes, there called typhoons, by its share in developing the now splendid Philippine Weather Bureau.

Tropical cyclones are great whirls of air, comparable to the more intense cyclones or "Lows" of mid-latitudes, but usually smaller and more intense. By imagining a dust whirlwind magnified until its diameter is more than 100 miles, one can obtain some idea of a tropical cyclone. They resemble a tornado in the strength of the inwhirling winds, in the irregularity of their movement and in being most frequent in one season. They differ from tornadoes, however, in several respects. While few tornadoes are destructive over a belt wider than a quarter of a mile or longer than thirty miles, tropical hurricanes may cause great damage throughout a belt a few hundred miles wide and a few thousand miles long. But, on the other hand, the wind is nowhere as strong as within a typical tornado. As to season of occurrence, while tornadoes are most frequent in spring and early summer, tropical cyclones most often occur in late summer

and autumn. Another difference in the season of occurrence of tornadoes and of tropical cyclones is that tornadoes practically never occur except in spring and early summer, while tropical cyclones occasionally occur in every month of the year.

Although the essential characteristic of tropical cyclones is the strong inblowing winds, their destructiveness is only in part directly due to the winds. Indeed, upon the sea and along coasts the wind itself is of far less concern than the powerful waves which the wind produces. Furthermore, upon low-lying coasts and islands the actual rise in sea level at the storm's center often is frightfully destructive. This is produced chiefly by the piling up of the water by the inrolling waves, but to a slight degree it is the result of the low atmospheric pressure characteristic of the central area of strong cyclones. When the pressure in the center of a typhoon approaches twenty-eight inches while that around the margin is thirty inches, the level of the sea is forced up about two feet by this "partial vacuum." The inrolling waves raise the general level often several feet higher, and the mountainous waves themselves, occurring on this elevated sea-level not rarely reach points which are twenty feet above normal high tide. Low-lying islands have repeatedly been crossed by the waves at such times. There is one authentic case where typhoon waves reached a point on an island forty-six feet above sea-level. Wall-like waves five or ten feet in height often advance far up the streams upon level coastal plains drowning many people far from the sea itself. Another method of destruction is due to the downpours of rain which are almost characteristic of tropical cyclones. Frequently several inches of rain falls in a day or two while the storm is passing, and sometimes as much as 20 inches. Indeed, there are official records of 60 inches in three days. As a result of such heavy rainfalls, small streams swell into dangerous torrents, and much low-lying land is flooded. The destruction does not cease, moreover, when the flood abates, for the pools of stagnant water, the numerous dead animals, and the intensified poverty of the people in the damaged area combine to increase disease.

It is thus apparent that tropical cyclones merit study in the effort to lessen their destructiveness. Many forces of nature such as gravity, fire and vulcanism are even more destructive to those who do not know how to avoid them. But while the effects of gravity and fire are taught to little children, there has been a tendency to ignore tropical cyclones and to speak of them, if at all, as very rare phenomena confined to restricted areas.

It was the writer's good fortune to be selected by Yale University and the Bishop Museum of Honolulu to make a study of the tropical cyclones of the Pacific. Many island groups were visited, and much data was gathered. The expenses of the field work were covered by grants from these institutions and from Indiana University. Conferences were had with the directors of the meteorological observatories and weather bureaus of the Territory of Hawaii, of Australia, of the Philippine Islands, of Hongkong, of Shanghai and of Japan. The Monthly Weather Review, Washington, D. C., has already published technical articles on the occurrence and frequency of tropical cyclones in the western South Pacific, in Australia, in the southeastern portion of the North Pacific, and in the Far East. A monograph in which the effects of tropical cyclones as well as their frequency and distribution are discussed will be published later by the Bishop Museum.

What facts about tropical cyclones especially merit attention? Briefly, tropical cyclones are great whirls averaging about 300 miles across which develop usually in latitudes 10-25 and which move slowly westward or poleward or both. Some storms go westward for a long distance before they turn towards higher latitudes, while others move almost due north in the northern hemisphere, or south in the southern. Some recurve, after moving westward, a distance and then move eastward in higher latitudes. Occasionally a storm will go in the opposite direction from the normal course and many never reach high latitudes. The normal course of storms and the wide departures from normal which sometimes occur are clearly shown in two charts of typhoons published elsewhere.* Although tropical cyclones are rare nearer than about ten degrees away from the equator, they are by no means lacking, and sometimes are destructive within three degrees from the equator. Although few originate more than twenty-five degrees from the equator, many remain destructive until they reach high latitudes. Although most are destructively powerful over a belt some three hundred miles wide, some produce gales over a belt 1,000 miles wide, while others are much smaller than the average, causing damage in a belt perhaps only fifty miles wide.

As to speed traveled, most tropical cyclones move only from 100 to 300 miles a day while in the tropics. Some, however, travel 500 miles in twenty-four hours in while still within ten

*Notes on Typhons with charts of normal tracks and aberrant tracks, Monthly Weather Review, Vol. 50, pp., 1922.

degrees from the equator, while many travel that fast after leaving the tropics.

As to annual frequency. About two dozen typhoons occur annually in the Far East of which about twelve or sixteen are very severe. On the average four "extraordinarily" severe typhoons cross the Philippines each year and 5 of lesser severity. In the Southern hemisphere, perhaps a dozen tropical cyclones normally occur annually in longitudes 160° E. to 140° W. while a like number occur in and near Australia (100° E. to 160° E.). A region of similar extent in the South Indian Ocean (longitudes 40° E. to 100° E.) appears also to have about a dozen a year. In the southwestern portion of the North Pacific between Mexico and Hawaii, there are an average of about two tropical cyclones a year. In the West Indies, Gulf of Mexico and Caribbean there are usually four or five hurricanes a year, while in the Bay of Bengal there are about two and in the Arabian Sea about one. Thus in these several sections of the tropics, on the average there are nearly seventy severe tropical cyclones a year. This figure does not give the world total, however, for in the other half of the tropics of the Southern hemisphere, and in the less well-known portions of the Northern tropics, tropical cyclones, while rare, are yet not entirely lacking.

What can be done to lessen the destructiveness of tropical cyclones upon the land? The wisdom of locating all dwellings or other valuable buildings at a height of at least twenty feet above sea-level is apparent. Neither should such buildings be located where torrential floods may readily strike them. Buildings should be strongly constructed to withstand the wind. Indeed, it is very desirable that a portion of the dwelling be of reinforced concrete, with an independent roof, so if the remainder of the house, and the main roof are torn away, a haven of safety will remain. Dependable warnings as to approaching hurricanes should be obtained as promptly as possible so that in the two or three days of grace, before they arrive, preparation can be made for them. Livestock and other valuable property can often be gotten out of the way of floods and sometimes crops ready for harvest can be garnered. Another thing should be done. In all the tropics, property should be insured against tropical cyclones. At present it is almost impossible to obtain this protection at reasonable rates. However, the likelihood of any given small area being crossed by a destructive hurricane in any given year is rather small in most parts of the tropics. Indeed the chances

that a particularly well-constructed and carefully located house in most parts of the tropics will be demolished by a hurricane is perhaps not much more than the risk that a frame house in Illinois will be struck by lightning, otherwise burned or be damaged by a tornado. It is hoped that fuller data as to the frequency and other characteristics of tropical cyclones, which the writer and others are making available, will encourage insurance companies to undertake insurance against tropical cyclones in the portions of the tropics where they are not frequent. But it seems probable that the governmental insurance will be necessary if the great resources of the stormier regions are to be fully utilized.

It must not be thought that tropical cyclones are wholly detrimental. They induce most of the rainfall in many regions which otherwise would be dry, as on the leeward side of mountains in the Trade Wind belt. They encourage alertness and preparation in a climate where man is likely to be carefree. The changes they produce in an otherwise monotonous climate tend to stimulate people to activity. They encourage not only forethought and preparation but scientific research and widespread cooperation. They are beneficial in many other respects which will be discussed elsewhere. Hence tropical cyclones are illustrations of the great rule that every force and happening in Nature has both favorable and unfavorable aspects.

PRODUCTION OF STONE IN 1921.

About 62,400,000 short tons of stone was quarried in the United States in 1921, according to the United States Geological Survey, Department of the Interior. This is more than twenty percent less than the production in 1920. The estimated value of this stone is $92,500,000 a decrease of thirty per cent as compared with 1920.

Producers all over the country stated that both wages and prices had been reduced, and nearly all reported a decrease in the cost of production. High freight rates are said to have contributed largely to the general depression in the industry.

Building stone was in but little demand, and the returns at hand indicate a decrease in output of about 25 per cent. The output of monumental stone, which has shown practically no diminution during the last five years, apparently decreased more than forty-five percent. Paving blocks were in great demand, and increases were shown in the sales of curbing and flagging, facts that indicate a revival in street work in cities and towns. The campaign begun for the betterment of suburban and country roads caused an increase of nearly eight per cent in the output of crushed stone. Depression in the metal-smelting industry was reflected in a decrease of more than fifty per cent in stone sold for fluxing and for use as refractory material. Decreases were noted also in the demand for agricultural limestone, and for stone used by alkali works, sugar refineries, paper mills, and in other manufacturing establishments.

THE LABORATORY END OF THE GENERAL SCIENCE COURSE.

By Francis D. Curtis

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The rise in importance of the laboratory end of general science within the past few years has been both significant and gratifying. From a very subordinate position, in many cases if not omitted entirely merely tolerated as a side issue of more or less doubtful significance, the laboratory end, the term being interpreted in its broadest significance, is rapidly coming to be regarded as *the* course, the backbone of the work from the standpoint of instruction, pupil interest, accurate information, and all around training and development, to which the text-book plays only a minor part.

But in harmony with the above statement the laboratory end of *general* science must be defined so as to include all phases of the work by which the student, himself, observes scientific phenomena at first hand, and must therefore comprise all formal demonstrations, the performing of experiments by students, and student investigation, i. e., all the collecting of data by the student in connection with the course, both inside and outside of school. This interpretation of the meaning of laboratory end, beyond the limits usually, or perhaps it would be more correct to say, formerly assigned, is amply justified by the rapid evolution of this phase of the science work.

Not many years have elapsed since the time when, generally speaking, practically no student laboratory work of any sort was given; the entire course consisted of one text mastered in detail. Description of experiments, which, in the words of one of the teachers of that time were "so well explained that to have the students perform them was an inexcusable waste of time," took the place of actual manipulations. A forward step was that of demonstrations entirely by the teacher. Then with the developing of the idea of actual manipulation of apparatus by students came the rigid laboratory manual with its stereotyped set of directions, usually followed inch by inch without thought of destination, by the student who, having finally worked out the thing to the end, usually retained no memory of the path by which he had arrived. Finally we are arriving at a very important and significant step in laboratory teaching of general science (or for that matter, of all science), the problem, or, as it is more usually though perhaps less correctly termed, the project method.

It is correct to say we are arriving at the project method of teaching general science, for as yet this method is so new as to be itself in the first experimental stages; there are too many obstructions to the rapid adoption of a method so far removed from the educational ideas and ideals through which we are emerging. Along with the conservatism which, always active against any pedagogical changes, is possibly more than usually reluctant in accepting this new method, other factors equally potent oppose the widespread adoption of the project method: haziness regarding just what the project method is, is more or less general; the relative ineffectiveness of the method under a teacher poor in natural teaching ability or training, or in both, and the difficulty of securing always a higher type of instructor which the method demands is a further hindrance; then the frequently valid objection that the project method *may* tend to encourage exploration of seductive random by-paths, which do not conform to any *course*, makes the plan a target for administrative shafts generally.

But vital, practical, project work of the highest value to the student is a possibility in any general science course wherever conducted. Such work falls roughly into three classes, and the extent to which each is employed is determined by all the conditions governing the work. There is, first of all, the purely project course in which there are no restrictions or requirements of course content whatever, and therefore each student is free to select any phase of elementary investigation which may appeal to him within his scope of scientific possibilities; and his inquiry along the lines of his chosen topic constitutes his course, there being as many different courses as there are students in the class. The teacher holds himself as much in the background as possible, keeping track of progress, encouraging, and advising. A noteworthy example of this kind of project work was that done several years ago by the members of a small class in the Campus High School of the University of Oregon, who under ideal conditions, directed by a teacher, Mr. Giles M. Ruch, who is second to none, set a standard which is all but unattainable. The educational value of such work to the student engaging in it is paramount; yet the present conditions under which most of us work, the having to lead all our classes through a certain more or less prescribed and standardized course, makes its employment, except in sporadic instances, practically impossible.

A second kind of project which can usually be introduced with any ordinary laboratory class in general science consists of the working out of the answers to questions which suggest themselves to students during regular experimentation or demonstration. For example, during an experiment upon the weight of air, a student becomes curious to know whether a smashed light globe would still weigh the same as when it had only the tip broken off.

A third type of project work, less valuable than either of the others, and yet probably better than any non-project method, is the quasi-project assigned definitely to certain members of the class to be worked up and presented by them as a demonstration before the rest of the class. Meagre equipment facilities, which will not permit of extensive individual work, are much better utilized for demonstration in this way by *pupils before other pupils* who know that they, too, will later have their turns at being "teacher," than by the teacher, himself, before the same class. Practically all the general science experiments can, as a last resort, no other project method being possible, be made to come in this class.

But a well-planned course will contain something of all three methods; for there is sure to be some part of the work, as for example, that upon bacteria, yeasts, and molds, which will serve almost as purely individual project work, requiring only checking up in class. In general the more nearly the course approaches individual student project work, the more popular and valuable it will be.

There should always be, of every general science course, as large a portion as possible devoted to class experimentation and demonstration. But along with every elementary science laboratory course, however circumscribed by curriculum requirements regarding the ground to be covered and the number of experiments to be performed in school, as an auxiliary though at the same time required part of the course, every student should engage in an open air project of his own choosing. This extra-class project differs from the pure project course previously described chiefly in degree, and is probably the only practical way in which, under the usual restrictions, a teacher may provide his students with some of this more valuable kind of work. In this, since the subject of general science is all-embracing, there should be no restrictions put upon the choice, within the possibilities of the environment; the student should be allowed to

choose as a topic anything which he would like to find out about for himself, and which he can to a worthwhile extent, study out with the aid of proper reference material; and the subject should be such that its pursuit will take the student out of doors. A few titles for such student investigation might be, "Wild Flowers," "Moths and Butterflies," "Wild Fruits of this Locality," "Mushrooms," "Life Histories of Various Insects," "Rocks and Minerals of This Vicinity," "Stars and Constellations Visible from My Home," "Weeds," "Evergreens," "What Kind of Fertilizer Is Best for My Garden." Such titles suggested to the class with the understanding that the members are at liberty to choose one of these or any other practicable topic, they may prefer, will elicit a surprising variety of desirable and feasible projects.

Fundamental training in scientific inquiry, such as this, carries with it benefits which can scarcely be overemphasized. It demands first hand observation; it cultivates the proper modes of working and the proper attitude toward such activity; it encourages honesty, and develops initiative and independence; it stimulates the formation of ideals of work; it fosters appraisement of one's own efforts and through this, a proper evaluation of results, all to an extent which no "cut and dried" class work could effect.

No teacher need hesitate to initiate such auxiliary project work for fear of getting beyond his depth, or of being stumped by the problems which the students during the course of their investigations may bring to him for settlement. It is impossible that any teacher, however broad and extensive his training for general science, could hope to know the answers to a tenth of the questions which are sure to arise during such individual project work of any class. It is, therefore, both wise and honest for the teacher at the start, to state plainly to the pupils that he does not expect to pose as an authority upon the portions of work done outside of class, but that he expects every member of the class to have learned more about his own particular project by the end of the year than the teacher, or any other member of the class, knows. Because of such self-protective frankness the teacher loses nothing of the respect of the class, but he does open the students' eyes to a broadening perspective of the way in which the bounds of scientific knowledge are extended, which is invaluable to them. Each teacher possesses a sufficiently mature judgment to enable him to help the pupils to decide upon practicable projects, and this, plus enthusiasm and en-

couragement, is about all the help the student will need. Occasionally the teacher will want to show how to trace a wild flower in a key, to mount a specimen of flower, insect, etc., or how to identify a mushroom or butterfly from the appropriate reference books, but this any high school science teacher can do with reasonable assurance and accuracy, after a little study and practice. It is good for the student to run into difficulties during his investigation, to sense imperfections in his work, and to realize that there probably are errors in his classification, as there are doubtless errors in the work of most or all of even the most skilled investigators, which needs to be checked up by other research students. The pupil should be urged always to do his conscientious best, with the idea ever before him that he, only, profits by this first elementary inquiry of his, and then, only to the extent of his honest efforts; that the value of such work to him lies in the training he receives, to which the results he may obtain are secondary.

There should be no minimum requirements set for any of this auxiliary project work; no fixed number of wild flower specimens to be collected, mounted, and to the extent which seems desirable, if indeed in a beginner's project it seems desirable at all, classified; no certain number of sketches, and descriptions of mushrooms, wild fruits, etc. For minimum requirements in this, as in every other kind of work, invariably become maximum limits of endeavor. The ideal should be constantly emphasized to the student, therefore, that however well he may do, he has not exhausted his own possibilities in that direction; however much he may dig out concerning any particular thing, there will always remain an infinite vista of problems awaiting his own and others' efforts at solution; and that all can probably never be hoped to be known in any line of reserach however finely differentiated.

But in order to initiate such work successfully, each school must be equipped with something of a reference library as part of its laboratory equipment, as necessary and important as any other part. This library need not be extensive at first, a few volumes carefully selected with a view to maximum utility where reference to authority is apt to be required, to which nucleus other titles can be added from year to year, is an investment which will pay increasing dividends. A floral key, a mushroom book, a butterfly book, a moth book, a descriptive astronomy, etc., are a few volumes which should be found in

such a reference library, each book the best obtainable in its particular field, regardless of price. Fifty dollars, judiciously expended, will afford a good start toward such a library, and other volumes can be added from time to time as need arises and funds permit. And aside from their mere utility value in connection with the various student projects, these books, convenient to hand in the school library, will exert influence upon other students than those directly concerned with their use; if the books are available students will be tempted to open them with inevitable broadening of horizon and stimulation toward widening scientific interests.

If a general science laboratory course is to fulfill its mission as foundation training for subsequent courses, there must be definite training in the taking and the recording of results. The student should be encouraged to have always at hand a small notebook in which to jot down quickly in pencil his observations while the experiment is being performed, or at the time the field observation is made. He should then be trained to organize the roughly recorded data into workmanlike reports, the field notes uniformly in a style best suited to the particular project, and the class demonstrations and experiments into the more or less standard, logical form, consisting of a purpose or statement of the problem, a method which includes both manipulations and observations, a conclusion stated as completely and definitely as possible, and a sketch diagram completely labelled. This method of reporting is soon mastered by the pupil who is able after a little practice, to jot down in his note-book from his notes a complete and accurate penciled report in proper form, acquiring thus not only sound training which will stand him in good stead in subsequent science work, but gaining by this analysis of the experiment a thorough understanding of it.

The maximum amount of originality in writing should at all times be encouraged. But this can never be accomplished by a student if he works from the complete, conventional type of detailed laboratory directions. It can only be effected through the use of the skeleton outline which consists of a statement of the purpose or object of the experiment followed only by the *headings*, "Manipulation," "Observation," and "Conclusions," with perhaps guide questions to assist in formulating the latter. The student is thus required to develop his own powers of observation, deduction, expression, and most important of all, *independence*.

MATHEMATICS FROM THE VIEWPOINT OF AN ACTUARY.

By C. O. Shepherd

Missouri State Life Insurance Company, St. Louis, Mo.

This club owes its existence to your interest in mathematics and your faith in its value as a means of educating the mind. When I was asked to speak to you on the value of the study of mathematics in the high school, the subject came so nearly home to me and my convictions were so strong that I felt it was a duty and a privilege which I must accept.

To appreciate one's opinions on this subject it is essential to have his point of view. While I am engaged in a profession which numbers among its members many mathematicians of high standing, I am not primarily a mathematician but rather an actuary. I believe it will not be amiss, therefore, if I tell you briefly what is required of the actuary of today.

It would be an interesting story, but altogether too long, to sketch the process of evolution of life insurance and actuarial science; to go back to 1693 when Halley published his mortality table; to relate the theoretical controversies and arguments that involved the mathematicians of the following century; to tell of the speculative enterprises that left only one insurance company surviving in England in 1720; to record the growth of their modern institutions during the scientific period, which is commonly assumed to date from that time; to turn to the United States where the speculative period did not end until nearly 1840; to recount the beginning during the next decade of several of the finest institutions today; to note the rapid growth of state legislation and supervision of insurance during the sixties; to dwell on the many failures of life insurance companies during the seventies; to review the legislative investigations of 1906-07; and finally to tell the story of the tremendous growth of life insurance companies from that date to the present time. But, as I have said, this is far too long a story.

Aside from his knowledge of actuarial mathematics, in itself a wide field, the actuary of today must qualify himself to decide what class of risks his premiums will insure and in this task he needs every bit of knowledge he can obtain in regard to published mortality tables, their underlying data and peculiarities, so that through many comparisons he may learn to appraise and weigh properly the various factors that enter into mortality rates. He must have this information to instruct the agents of his company as to the classes of risks which they may solicit, and to decide

among those offered which may safely be accepted. He must be prepared to appraise properly the effects of occupation, habitat, variation from standard weight, family history, etc., and in recent years he has been called on, with the Medical Director, to determine the effect of many physical impairments which in the past have been sufficient cause of declination, such as heart murmurs, albumen, and sugar, many cases of which are now accepted at special rates.

He must know something of interest rates and their future course because the level premium legal reserve system of life insurance involves the accumulation of vast funds which must be safely and profitably invested if insurance is to be furnished at a reasonable cost.

He must determine what surrender values or non-forfeiture insurance values his policies may provide at various ages and on various plans to protect the company and be equitable as between different policyholders and between policyholders and the company.

He must draft his policy forms so that they will be liberal enough to sell in competition and yet be safe from the standpoint of the company, be clear and readable so far as possible to the agent and the policyholder and yet exact and definite enough to avoid difficulty when they are brought into court. They must conform with the laws of the various states in which his company does business, laws which differ as between the states to a degree which taxes his ingenuity.

He must determine his dividend scale so that dividend refunds will be fair and equitable, a duty that often requires a good deal of common sense and frequently some very nice investigations.

He must prepare financial statements at frequent intervals, and this, with its complexities, is not a task to be despised until he has worked out all his formulae and methods in the light of his own company's peculiarities. He must devise exhibits simple and clear enough to impress his fellow officers, showing the influence of various factors on the company's experience and development, including studies of mortality according to age, duration, plan, habitat, and impairments. In other words, he should be something of a pilot to his company.

I have not by any means exhausted the duties which frequently devolve on him but have given you an idea of his work.

Not once a month perhaps does a chief actuary of his company set down even a simple algebraic equation, but not an hour of

work passes but what his mathematical training pays its tribute and demonstrates its value and necessity. Reserves, surrender values, premiums, dividends, mortality gains or losses, extra mortality ratings are concepts that have for him a living reality, an intimacy that can never be for the non-mathematical.

But, as I explained when I accepted this invitation, the world's need for actuaries is limited, though by that I would not in any way imply that the field is over-crowded. It is not my idea to argue that high school students should be trained in mathematics because the actuarial field needs them. In my judgment there is a far bigger and better reason.

What place has mathematics in the high school course? It is accepted today that the purpose of the school is to train the mind in ways and methods that will enable it to know and appreciate as far as possible the world of reality in which it is to live, a world of which only the faintest outline has perhaps been traced, a world that may never be defined. The aim is not to fill the mind with facts but to teach it how to function so that it will be able to acquire facts as they are needed in order to live—and life is a comparative term—some people live more than others.

"We should count time by heart throbs, not by figures on a dial.
He most lives who thinks most, feels the noblest, acts the best."

I believe there is no subject in the high school course today which offers a student more opportunity for original, independent thinking and logical analysis than mathematics, and none in which the instructor can so readily measure the extent of that mental effort and the student's success.

Over and over and over again the problem in mathematics stands as a challenge for thought, real mental effort, and when solved yields a peculiar satisfaction that is its own reward and a stimulus to repetition, a reward and a satisfaction that is so sure and so immediate that there is a strong tendency to create a thinking habit.

Failure to think reveals itself inevitably to the instructor who is then in a better position to direct the pupil's efforts along new lines until the mental process does become a habit. Then, too, there is no room for doubt in the student's mind as to whether he has succeeded or failed, and if he has failed pride may eventually lead to success. How many other studies are there that meet these tests so well?

The habit of solving mathematical problems develops mental courage, the ability to see problems, to state them, and the desire to find their solution. I mean the problems of life in the

practical everyday world. I long ago observed that the college mathematical student in our work showed a healthy, mental curiosity in marked contrast to the apathetic reaction we so frequently find where work has developed beyond the point of mere routine, one eager for the challenge, the other fearful and downcast at the obstacle.

Does not the study of mathematics teach the student to look beneath the appearances for the facts, teach him that appearances are often deceptive and make him less likely to base his actions on a false foundation?

The study of mathematics must eventually make the student realize how wonderfully systematic the structure of fact in this world is, teach him to generalize from the specific facts which come before him. If there are other studies that also serve this purpose there are none that do it more impressively.

My observations are drawn from my own experiences in the business world. I have never taught mathematics and never had an opportunity to be associated with those who have. I am interested in anything educational because it is one of the biggest forces under our influence and control.

I have had more opportunity than the average business man to compare minds with mathematical training with those that lack it and while I make no invariable rule I do say that the conclusion is inevitable that the trained mathematical mind reasons better, sees relations more quickly, shows more mental confidence, is more accurate and more certain and reliable as to its statements than the mind, without mathematical training, otherwise equally intelligent.

We live in a world where logic is a truth and a reality, a world that has revealed itself in astounding manner to the process of reason and a world to which he must always be more or less a stranger who does not like to reason. How many ills the world has groaned under might have been overcome if man had been more of a reasoning animal? How many of the ills of today are founded on the fact that man does not know how to think or lacks the habit? The mind that does not think or thinks only superficially is at once a credulous mind and a suspicious mind, an instinctive confession of its inability to discriminate. If the student of today can be taught to think his schooling will have been a success.

Nothing I have said has been said to disparage the value of other studies commonly pursued in high school. My argument

is constructive and is to emphasize my belief that the study of mathematics has a peculiar value and importance.

The actuary frequently finds he must overcome a prejudice among his fellow officers against his views on matters which fall outside his technical field. His devotion to his profession is assumed to have been at the sacrifice of other faculties and warped his judgment. Perhaps a mathematics instructor encounters the same sort of difficulty among his fellow educators in other fields. The burden is on him to demonstrate that his mathematical pursuits have not made him one-sided. We must not be zealous to the point of antagonism or intolerance or we shall retard our course and not advance it. Life is not an exact science and we must not apply the mathematical yardstick indiscriminately—there are other measuring rods which we must recognize. Sound reasoning has never yielded anything but truth, but we must not forget that much truth has been revealed in other ways.

We should aspire to that state of mind and outlook on life so well described by Marcus Aurelius.

"Make for thyself a definition or description of the thing which is presented to thee, so as to see distinctly what kind of a thing it is, in its substance, in its nudity, in its complete entirety, and tell thyself its proper name, and the names of the things of which it has been compounded, and into which it will be resolved. For nothing is so productive of elevation of mind as to be able to examine methodically and truly every object which is presented to thee in life, and always to look at things so as to see at the same time what kind of a universe this is, and what kind of use everything performs in it, and what value everything has with reference to the whole, and what with reference to man, who is a citizen of the highest city, of which all other cities are like families; what each thing is, and of what it is composed, and how long it is the nature of this thing to endure."

To encourage and reward high attainment on the part of students in secondary schools, the Cum Laude Society was founded at Tome School, Port Deposit, Md., in 1906. Twenty-one schools, including Exeter, Andover, and Penn Charter, have chapters in the society. Each chapter may elect as members those students of the highest class who have an honor record up to the time of election and who stand in the first fifth of the class. The constitution has been amended to open the society to girls, who were formerly excluded from membership. Dr. John C. Kirtland, of Phillips-Exeter Academy, Exeter, N. H., is secretary general of the society.—[School Life.

"REPEATERS" CLASSES IN ALGEBRA.

By Jos. A. Nyberg,
Hyde Park High School, Chicago.

The separation of freshmen into groups by means of intelligence tests raises the question of how a subject like algebra should be modified to fit the various groups. We may (1) require the lower group to cover all the topics covered by an upper group but do only the easier exercises in each group, or (2) we may omit some of the topics and then expect the remaining topics to be covered thoroughly, or (3) we may replace the algebra by another subject such as "general mathematics." A similar question arises in regard to "flunkers" or "repeaters" classes in algebra: How shall we modify the algebra for a class which is beginning algebra once more after failing in the first attempt? General mathematics is out of the question if five months later the pupil must be able to fit into any other class in the school program or if there will be additions afterwards consisting of pupils who have failed in their second semester's work; that is, every class must be so taught that pupils entering or leaving at the end of the semester can fit into any other regular class. Further, whatever the plan may be, it must take care of the pupil's lack of interest due to repetition and his varied interests in those particular topics which caused his failure. Having handled in the last five years eight such repeaters' classes, averaging thirty-eight pupils each, my experience and methods may be of interest to others.

At the beginning of the work the teacher must adopt some hypotheses concerning (1) the pupil, and (2) the subject-matter. Unless the rush of work due to crowded schools prohibits it, a five-minute interview with each pupil is of decided value in acquainting the teacher with the pupil. In such an interview my first question is always: What is *your* explanation of why you failed last semester? The common excuses given are: absence through illness, or outside duties before or after school; sometimes the pupil blames a specific topic as factoring or "those story-problems." It is both amusing and embarrassing to note the frequency of "Oh! The teacher never explained anything." With such a pupil I discuss: Were you always listening and paying attention? How many times were you doing your English lesson in the Algebra class? Did you stop the teacher in her explanations to have her repeat the point that bothered you? Are you too bashful to ask questions? Whose fault is it if you

pretend to understand a problem, ask no questions, and then are unable to solve similar problems? Suppose you understand a problem in class but find you can not work similar problems at home; what is wrong and how are you going to remedy it? As a last question I always ask: What measures are you taking this semester to avoid a repetition of failure? It may be evident from the interview that the pupil's explanation is unsound, but even so the pupil's opinion of his past is a guide to what may be expected of him in the future. Above everything I aim to impress on the pupil that it is his duty to ask questions and his privilege to halt the recitation at any time when it gets beyond him.

Secondly, the teacher must adopt a hypothesis regarding *algebra* itself: is the teacher chiefly interested in unravelling *algebra*, or in developing the *pupil*? I can best illustrate the difference as follows: if a class is studying the graphing of linear equations I might emphasize as soon as possible that a line is determined by two points and hence only two corresponding values of x and y need be found. But under the second hypothesis no mention or use is made of this fact until some pupil in the class himself discovers it. An entire period of questioning and leading may be needed before any one does discover it, so that the work is decidedly slower and much less information about algebra is accumulated by the end of the semester. Under the first hypothesis algebra is an end in itself, a preparation either for the second course in algebra or for the actual needs of the pupil as a member of society.[1] In my experience only two or three of the thirty-eight will take the second course in algebra; and the actual needs of the pupil will be taken care of under either assumption. Therefore, I have always chosen the second assumption: algebra for its disciplinary value. Since the National Committee on Mathematical Requirements has admitted that such values do exist, we may now breathe easier on this point.[2]

The teacher must next select those topics which conform to the hypothesis. Inasmuch as the pupils are repeating algebra and have a smattering of everything, we may assume that they know the law of signs for handling negative numbers. As a

[1] In this connection see the article, *The Uses of Algebra in Study and Reading*, by *E. L. Thorndike and E. Woodyard*, School Science and Mathematics, June, 1922, page 514.

[2] Bulletin 1921, No. 32 of the Bureau of Education, pages 6, 7. Should any reader inquire just what faculties are trained or disciplined, I refer him to a most remarkable article, *The Mind as Misrepresented to Teachers*, by *Geo. M. Stratton*, Professor of Psychology at the University of California, published in The Atlantic Monthly, March 1921.

means of drilling in arithmetic we begin with two weeks' work on formulas. The extensive use of checks in algebras is very likely due not so much from a desire to discover errors as to furnish such a drill in arithmetic. The arithmetic of checking, however, is unfortunately confined chiefly to positive integers, 1, 2, 3. By using formulas we may get a better drill covering fractions, decimals, and negative numbers. This work is followed by the solution of linear equations and problems involving them. Next we consider fractional equations with monomial denominators 2, 3, 5, . . (not x) and any type of numerator. This enables us to treat simultaneous equations next even though this topic ordinarily falls into the second semester. Graphs are also treated at this point. The rest of the semester, usually about four weeks, is devoted to multiplication of binomials and factoring in order that the pupil may fit into any regular class in the school program for the next semester. Perhaps I should repeat that this arrangement is for a class of repeaters, and hence the omission of long division is not fatal as the pupil did learn a bit of that during his first treatment.

The arrangement shown above is suitable, I believe, not only for a class of repeaters but also for a class of below-average pupils. The progress would necessarily be slower, but there would be ample time during the second semester to consider the omitted topics because graphs, simultaneous equations, and parts of fractional equations have been treated. Moreover, the more formal topics which have a less arithmetical background are placed in the second semester.

The justification under the second hypothesis (algebra for its disciplinary value) of the above choice of topics can best be seen by showing how the difficulties of the subject are used to train the pupils. The work hinges on the study of equations; and equations are studied because they are needed to solve problems. Hence, much of the work consists of story-problems. The difficulties with these problems may be considered under three heads: grammatical, arithmetical, and algebraic.

1. By grammatical difficulties I mean a careless reading of the problem or an inability to parse a sentence, especially an inability to appreciate the significance of adjectives, prepositional phrases, and modifying clauses. At the beginning of the year, and occasionally thereafter, the pupil is asked to precede his attempted solution of a problem by an analysis of each sentence exactly as he is taught to do it in his English classes.

Suppose the problem is: Three boys earned \$38. The second earned \$11 more than the first, and the third earned \$6 less than the first. Find how many dollars each earned. The pupil recites: *Boys* is the subject; *earned* is the verb; *dollars* is the object; *eleven* is an adjective modifying *dollars*. In his written work the pupil "diagrams" the sentences in the manner taught in the English classes.

A teacher of algebra may insist that such work belongs to the teacher of English. If, however, our interest centers on the *pupil* then it is immaterial in what particular room of the building the pupil gets his training. And experience has shown that this kind of work improves the algebra because it compels the pupil to read the problem more carefully than otherwise.

2. If the pupil shows that he understands the phraseology of the problem but complains that he "never knows what to do or where to begin," I use the following plan. Suppose the problem is:

A man has eight more dimes than nickels. If he has \$2.75, how many nickels and dimes has he?

Without attempting to solve the problem, let us guess at the answer and then check our guess to see if it is correct. Suppose the man has twelve nickles. Then he has twenty dimes. Now write in a vertical column each step of the check, explaining what arithmetical process is used in each step. The pupil writes:

Let the no. of nickels = 12.
Then the no. of dimes = 20.

12	20	Add 8 to 12.
5	10	Multiply no. of nickels by 5.
		Multiply no. of dimes by 10.
60	200	Add the value of the nickels and dimes.
	60	
	260	

For every story-problem which the pupil can not work, he is required to write out such an analysis. The pupil is told that in estimating his daily work with a view to determining his final grade, an analysis like the above will be counted just as if he had solved the given problem correctly *provided* his statements in the right hand column are correct. Then when the pupil shows me this work I say to him: Copy that work for me, but wherever you have written 12 (your guess) write x in its place. In doing this he will very likely find the equation or at least teach himself how to begin a problem. If the pupil can not then solve the problem, I can see where his difficulties lie. Instead

of writing "add the value of the nickels and dimes" he may have written "add the nickels and dimes." Or, when he substitutes x for 12, he may have written in the last step $5x+10(x+8) = 5x+10x+80 = 15x+80$, overlooking some of the information in the problem. The advantages of this method are that the teacher can quickly see a pupil's difficulties, and the pupil is compelled to work every day because there is always some work he *can* do.

3. To overcome the algebraic difficulties each pupil records in a notebook or in his textbook a few suggestions like the following:

In a coin problem, distinguish between the *number* of coins, and the *value* of the coins.

x and $x+2$ may be used to represent consecutive *even* integers and also used to represent consecutive *odd* integers. (Because 2 is itself an even integer there is always some difficulty in making the pupil remember that x and $x+2$ may be odd integers).

If we have written down the ages of A and B now, we can *without* algebra and *without* further information from the problem predict their ages n years from now or their ages n years ago.

When A gives B some money, A will have less money but B will have more. Write the result of the transaction before doing anything else.

If the sum of two numbers is s and one of the numbers is x, then the other number is neither sx, nor $x+s$, nor $x-s$.

Such suggestions are not handed out free of cost to the pupils but are developed in class. After a typical problem has been solved in class we have a five minute "experience meeting" after the fashion of the religious revivals. Each pupil who has failed to solve the problem must arise and tell what his troubles were, what he overlooked in the problem, what hindered his road to glory. After listening to the testimony or experience we record the most prominent difficulties. Later when a pupil fails on a similar problem, I ask before I help him: What does your experience book say about such a problem? Some teachers may contend that these suggestions destroy the value of the problem. What harm is there is recording our errors so that we do not make the same mistake twice? W. L. George in his lectures on *Hail Columbia!* remarked on the frequency with which he saw in business offices the placard "Experience is a dead loss unless you can sell it at a profit." As a teacher I find it useful to record on the margins in my textbook the pitfalls which lie before me or before the pupils in that day's work.

As subject-matter for the story-problems I use the customary problems on coins, mixtures, digits, consecutive numbers, ages, gifts of money, distances, rates—all the old-fashioned material so heartily scorned by those who do not have occasion to teach high school algebra. I have tried to avoid the use of such problems and find I can not do it. I can not spend an entire semester drawing graphs nor evaluating formulas; and there is little mental training in drawing triangles to scale or counting the number of squares inside a circle. All that is too easy. It is true that the pupil does not solve such problems after leaving school. Neither does he parse sentences. Neither does a prima donna sing scales on the stage; nor does a pianist rehearse in public his first grade finger exercises. In spite of their artificiality these problems are useful because (1) the difficulties can be classified, diagnosed, and are amenable to efficient treatment in large classes, (2) the pupil can in various ways check his results so that he may develop confidence in his abilities and an acquaintance with his weaknesses, (3) the problems will call for the exercise of judgment in selecting the mathematical processes (addition, multiplication, etc.) to be used. We are very near the truth in saying that in the first six or seven grades the pupil learns *how* to multiply, *how* to add, etc.; thereafter, we aim to teach him to select the particular process, to teach him *when* to multiply, *when* to add.

Every teacher knows that story-problems as a whole are difficult for the pupils. Regardless of how many diagrams, charts, and devices we may use, the pupils feel happier when they approach some easier topic such as long division, multiplication, or factoring. The textbooks on general mathematics and books which aim to follow closely the recommendations of the National Committee give less attention to problems of the above type and more attention to formulas and graphs. Until some one shows high school teachers how the new subjects can be taught so as to have the same disciplinary value as the other subjects[3] many teachers will continue using these fictitious problems., The argument that general mathematics is easier than algebra is not an argument *for* general mathematics but rather against

[3]Formulas are useful as a drill in arithmetic. Further, the pupil can understand graphs long before he can construct them. If a pupil leaves school at the end of the ninth grade (which is frequently stated as the reason why our curriculum needs reforming) is he very likely to reach such a high executive position that he will need to construct graphs and determine inaccessible distances; or is he more likely to be in the class of workers who apply the graphs and formulas constructed by some college graduate? Also, is it not likely that a mechanic can teach his apprentice more about the use of a formula in five minutes than a teacher can in several hours because the apprentice has an eye on his wages?

it. If we wished to teach what is easy instead of what is good training for the pupil, we could improve the situation still further by teaching him the multiplication table once more or anything which he has already mastered. The oft-repeated claim that tax payers will not stand for a high percentage of failures overlooks the fact that even the pupil who fails has learned something and has had some useful training. And the tax payer must not expect to purchase a Rolls Royce on a budget which provides only for a motor cycle.

MAKING THE DESERT SAFER.

GEOLOGICAL SURVEY SETS UP SIGNPOSTS AND PUBLISHES MAPS AND ROAD LOGS.

To those who have never been on a desert the word "desert" conveys the impression of a barren waste incapable of supporting life, a perilous stretch of waterless, lifeless land that separates areas of fertile land on either side of it. The word "desert," however, may have diverse meanings, for some deserts are much more inhospitable than others. Travel through any wide area of desert is nevertheless fraught with danger, for in such areas springs, wells, and water-holes are few and far between, and our American deserts have, year after year, taken their toll of human life. The recent work of the United States Geological Survey in mapping certain desert areas in the Southwest and in erecting at suitable places signposts giving directions and distances to springs and waterholes is therefore of special interest. In 1917 the Geological Survey, under authority contained in an act of Congress making a small special appropriation, erected signposts in the most dangerous parts of our southwestern deserts, giving directions and distances from watering place to watering place. The results of this life-saving work of the Geological Survey are being published in a series of guidebooks.

One of these guidebooks, the third of the series, by C. P. Ross, has just been published. It describes desert watering places in the lower Gila region, Ariz., including approximately the triangular area between Phoenix, Yuma, and Parker. It contains three large maps of the region, shaded to indicate the relief and showing the location of the roads, the wells, springs, and other watering places, and the signposts erected by the Geological Survey.

The paper contains detailed logs of the roads in the region, including not only those of the principal automobile routes but those of branch roads that lead to remote parts of the desert, which are seldom visited and little known. These longs show in heavy type the points at which water can be obtained. There is also a list of watering places, with brief information as to their location and availability.

The introductory part of the guidebook contains detailed information regarding difficulties encountered in traveling through the desert and suggestions for surmounting them. Anyone who intends to travel in this region should consult one of these guidebooks. Copies of this publication, which is numbered Water-Supply Paper 490-C, and entitled 'Routes to Desert Watering Places in the Lower Gila Region, Arizona," have been sent to the post offices, the chambers of Commerce, and the principal hotels and garages in the region and can be consulted at many of these places.

HOW TO GET A CLOSER RELATION BETWEEN THE CHEMISTRY OF THE HIGH SCHOOL AND THE COLLEGE: FROM THE STANDPOINT OF THE COLLEGE.[1]

By J. H. Reedy,

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The matter of the ideal relation between instruction in high school and in college is not merely one of cooperation, but also of adaptation of the work to the prime needs of the student. Very naturally, in the original working out of the general problem of affiliation, the idea of cooperation has been given primary consideration, and adaptation of work has been somewhat secondary. But now that affiliation is for the most part an accomplished fact, the question of differentiating high school work to suit the needs of the student requires consideration.

College teachers, it is generally agreed, have had a more or less dominating influence in the development and standardization of courses in high school chemistry. As a consequence, the college point of view has prevailed as to the purpose and nature of the course, with the result that high school chemistry has been largely a small-sized imitation of the first-year college course. This course has been followed without regard to the fundamental question, as to whether such a course is suitable for the student who does not continue his chemistry in college.

Exact figures are not available, but I think that I am safe in saying that not more than twenty-five per cent of the students who study chemistry in the high school ever go to college, and of that number only a part take collegiate chemistry. The question is, which should determine the nature of the high school course—the seventy-five or more boys and girls who go sooner or later into practical life, or the smaller group who go on with their chemistry in order to fit themselves for some specialized profession. This raises the more fundamental question, what is the purpose of high school chemistry, anyway? Is it valuable only in that it serves to purchase one more entrance credit to get into college on? If that is true, strict honesty requires us to exclude from the course all those who will probably not become collegians.

There is a certain group of college men whose theory is that the high school chemistry course should be planned to fit the needs of those who are contemplating college work, believing that such a plan very fortunately may not be so bad for the rest

[1]Read before Chemistry section of the High School Conference of the University of Illinois with its affiliated school at Urbana, November 24, 1921.

of the class. It is that theory that I want to combat. I hold that the high school course should be designed so as to give the maximum good to the maximum group; and further, instead of high schools adapting themselves to college conditions, colleges should make their entrance credits conform to high school conditions. I repudiate the old doctrine *in toto* that high schools exist wholly as feeders for colleges.

For the boy or the girl who is not going to attend college, what then is the ideal chemical course? Recently general opinion has been rapidly coming to the conclusion that the practical man or woman of today should know certain fundamental things about chemistry. The science is becoming more and more one of the world's most practical agencies, improving old industrial process and creating new ones that are to advance civilization and promote the well-being of the race. No man can be a real citizen of today's world, be at home in the vast maze of conditions that limit or extend human activities, without knowing something about what Slosson has aptly called "creative chemistry." More than 75% of our people must get this in the high school or not at all.

The best way to emphasize the importance of this need for general chemistry is to review the history of chemical instruction in England. Until of late years, chemistry (along with the other physical sciences) was not generally included in the curricula of the secondary schools. Even in the leading universities, like Oxford and Cambridge, it was not ranked as comparable in educational value with Latin and Greek, Mathematics and Philosophy. Inevitably the masses of the British people knew little or nothing of what chemistry really meant, and were completely out of sympathy with its possibilities and purposes. I am going to let a British scientist speak of this situation for me. I am going to quote two passages from "Chemistry in the Service of Man"—a volume written during the Great War by Professor Alexander Findlay, professor of Chemistry in the University of Wales and one of the world's outstanding chemists: "The (English) people as a whole, being ignorant of science, have mistrusted and looked askance at those who alone could enlarge the scope of their industries and increase the efficiency of their labors. And so we have witnessed in the past an appalling and needless waste of our national resources, and in many cases industries have languished and succumbed." . . . "The mental outlook and the attitude of the people as a whole towards

science must be changed, and the scientific habit, and a spirit of trust in science must be cultivated." Yankee industry and progressiveness does not propose that such a lament shall ever be written about the American people.

Conceding that it is self-evident that chemistry should have a large place in the program of the American high school, the next question is what should be the character of the course. First of all, it should be quite a different affair from the Freshman course in college, which must be largely theoretical, since it must serve as a foundation upon which to build courses in analytical, organic, industrial and physiological chemistry. High school chemistry, on the other hand, should be mainly informative, and should touch everyday life at as many angles as possible. The teacher who plans his high school chemistry course with this definite end in view will find that it differs from college chemistry in a surprising degree.

The time at my disposal is not enough for me to outline such a course in any detail. However, I am going to indicate as specifically as I can certain things that I think ought to be included and certain others that I think ought to be omitted.

The usual discussion of the elemental gases should be curtailed considerably. The student need not know much more about hydrogen and oxygen than the simplest preparation methods, their physical properties and their practical uses. The kinetic and atomic theories should be omitted entirely, as well as the gas laws, including Gay Lussac's law, which are important only in the determination of molecular and atomic weights. When it comes to nitrogen, the student should be made to know the critical importance of the nitrogen cycle in nature, how it is "fixed" either by bacterial action or by thermal and catalytic means. Of course he should also know the properties of practical importance of nitric acid and ammonia; of sodium chloride, hydrochloric acid and bleaching; of sulphuric acid and its action on salts on low boiling acids.

The general subject of combustion should be insistently presented, along with that less spectacular form of oxidation, decay. There is no better evidence of the abject ignorance of the masses on the subject of combusion than the appearance in the daily press of advertisements of a gas-making machine which, it is claimed, "burns air." Another advertiser manufactures a contrivance which he wishes to attach to the carburetor of motor cars for the purpose of introducing moisture into the gas,

claiming that in this way the engine may be made to "burn water." It is a strong indictment of the chemical commonsense of the American people that such advertisements will catch enough suckers, not only to pay for the ads, but produce a profit for the promoters. The high school instructor can do more than any one else to sober up some of the overcredulous by imparting a decent measure of chemical common sense.

Another group of theories that should be left to the college instructor is the ionization hypothesis, reversible reactions, the mass law, and so forth. I have had students who could talk glibbly about ions and ionic migration, and yet could not see why NaOH and HCl could not exist side by side in the same test tube. Instead of these difficult and rather impractical concepts, such simple principles as neutralization, valence and simple stoicheiometric relations should be ineffaceably impressed on the student mind. I believe that if he had had a different sort of high school instruction, a certain physician in New York state might have escaped the blighting fame that has overtaken him. According to a well authenticated story this physician wrote a prescription for a patient suffering from some digestive trouble, calling for dilute HCl as a specific for a sluggish gastric condition, mixed with milk of magnesia as an emollient for the intestines—HCl a strong acid and $Mg(OH)_2$ a strong base! The lion and the lamb lying down together according to the Scriptural metaphor had nothing on this combination.

When it comes to the metals, develop not only their properties and uses, but their economic aspects as well. Explain why iron ore is mined in the upper peninsula and smelted in Pittsburgh or South Chicago; why Missouri zinc ore is smelted in Danville, Illinois. Contrast the properties of alloys with their component metals, and show the marked changes in such respects as hardness, melting point, tensile strength, and so on.

Omit the Periodic Law. Or at the most, use it simply as a means of classifying the elements. The other year a young teacher asked me which form of the periodic table he should teach his students—the Harkins or the old Mendelieff form. I frankly told him to teach something that the students might be expected to learn.

Sodium hydroxide and sodium carbonate should be studied as to their commercial uses; hard water should be considered as to causes, behavior and treatment; likewise the practical aspects of mortar, cement and dozens of other topics of decided

human interest and importance. Towards the end of the course there should be taken up petroleum and its refining products; illuminating and fuel gases; simple cases of practical electrolysis and storage cells; the practical aspects of substances like sugars, alcohols, and related compounds, introducing an elementary study of fermentation and enzyme action.

The laboratory experiments should be chosen with this same purpose of giving the student as much usable information as possible. A small number of simple quantitative experiments should be given, to emphasize important relationships. As a general rule, however, the properties studied should be those which give the substance its practical importance. There should also be included a number of household and shop tests for impurities, adulterations and substitutions in every day commodities.

I am not sure that the usual plan of studying the nonmetals first and the metals last is the proper one. There is no doubt but that the metals are much more familiar to the beginning student, and that their properties and applications are much easier to grasp than in the case of nonmetals. For example, take iron and chlorine. The student is already familiar with iron and its uses; chlorine, on the other hand, he has never seen before, its properties are much harder to understand, and its chemistry is far more difficult.

I am not sure that qualitative analysis deserves any place in the high school course. I should include it only in case lack of laboratory facilities or supplies prevented the class from doing something more important. To the high school student, qualitative analysis is merely a stunt, the details of which are soon forgotten, leaving no abiding impression on his mind except that in some way he effected a separation. Furthermore, the portions of the general analytical procedure available for high school work are so fragmentary and unrelated that, even if accurately remembered, they would be worthless in an actual analysis. The only value of such work lies in its disciplinary quality.

The next question is, how well would this course of everyday chemistry fit a student for entrance into college work? I believe very firmly that it would be a vast improvement on the old, and I am going to make so bold as to point out some of the chief defects of the course as it is now all too frequently taught.

In the first place, I think the thing that is most radically

wrong with high school chemistry is that it is usually nothing but an undersized imitation of the Freshman course. This is due to a considerable degree to the fact that the teacher usually tries to teach just as he was taught in college. But another and less excusable reason for this imitation is an attempt to forestall the college course, so as to prevent failures of his students in the college subject. Aside from the questionable ethics of such a plan, the whole scheme works out wrong. It is a well substantiated fact that there is a higher percent of failures among students who have had chemistry in the high school than those who have not. Here at Illinois the best lecturers and quiz instructors are assigned to the high school groups with the hope of reducing this high mortality. The trouble is, the student in repeating the work of his high school course imagines that he knows much more than he really does, and hence loafs. A more subtle, but none the less obvious reason is that a student never has the genuine interest in a course that he is repeating that he has in an altogether new subject. I have heard several students say, "I enjoyed my high school chemistry very much, but someway I cannot work up any 'pep' over this Chem. 1a." The reason is plain. It is dreadfully hard to reanimate the corpse of a dead enthusiasm.

Another not infrequent error on the part of young high school instructors is the attempt to squeeze a whole lot of college or university chemistry into their course. I have had students try to talk to me about radioactivity and atomic decomposition —students who did not know the reaction between manganese dioxide and hot hydrochloric acid solution. The other day one of the quiz instructors here at Illinois was tutoring a girl in the room adjoining my office. He asked her to give an example of a base. "NaCl," she suggested. "No," said the instructor, "think again." After a moment's hesitation she suggested, "H_2SO_4." "For the love of Mike," stormed the instructor, "what did you study in the high school, anyway?" "Oh, lots of things, but we did not have anything about bases." No time to waste on such unimportant things, I presume.

Another kind of perversive instruction in the high school is that given by teachers who try to make their work as interesting as possible by stressing the mystic and bizarre effects—just anything that can be counted on to surprise and to stun the student. The recitation begins with an explosion and ends with a play of colored lights. I was talking not so long ago to a young

teacher who said that he thought the mercuric iodide experiment was one of the best in the book. I had to ask for information. "Why," he said; "you add some mercuric chloride solution to some potassium iodide solution, and you get the reddest precipitate you ever saw." "That may be true enough," I conceded. "But what does the experiment teach?" "Why, that red color! Isn't that chemistry?" He was the same fellow who set up on his lecture table samples of all the indicators, methyl red, methyl orange, methyl violet and all the rest of the methyls and made them first acid, and then alkaline. To be sure he got ample chromatic effects, but I allege that he taught very little chemistry. I hold that such theatrical effects, rather than increasing the effectiveness of the teaching, are actual hindrances. It is a fundamental psychological principle that the sensation of surprise or wonder momentarily paralyzes the mind so that it is incapable of thought. There are times when stunning experiments are in order, as when you wish to fix the student's attention on a definite and easily understood reaction, as the explosiveness of hydrogen-oxygen mixtures; but when performed simply for the sake of the element of surprise or shock produced, they put the student in exactly the wrong attitude toward his subject. Explosions and bizarre effects are strictly outlawed in plant practice, and the man who produces them is a menace, and sure to lose his job. The time is gone forever when chemistry is to be looked on as a sort of black art, inscrutible and mysterious; and the teacher who does not do all in his power to free it from such implications does not understand the spirit of the day.

This unfortunate zeal of the young teacher to make his course entertaining may operate in another way. He may use all sorts of expedients to sustain interest, such as having his class attend popular addresses and the so-called "educational" moving pictures, and by frequent excursions to industrial plants. I want to be careful just what I say along this line, for I do not want to be misunderstood. While a limited number of diversions like these may be of value, extraordinary pains must be taken to make them yield the profit expected. So far as a popular address is concerned, it is seldom as valuable as ten minutes of actual study. And as to the moving pictures, what is the actual value of a film on the manufacture of lead pencils or the fabrication of Limburger cheese? A visit to an industrial plant may be made very profitable, provided the student has before-

hand a very satisfactory knowledge of the principles involved, so that he may grasp the real significance of the physical processes which he sees in operation. The fundamental danger of this whole plan is that it fosters in the student a passive attitude of mind and superficiality of information. He never learns to do any constructive thinking, and his mind becomes flabby and his initiative dead. In chemistry as elsewhere, nothing worth while is ever obtained except by real, purposeful effort on the part of the student, and the entertainment method does not include that. A high school chemistry course that does not make the boys and girls work—yes, and make some of them fail—is not worth much.

By way of conclusion, let me return to the subject of this paper, "How can we best train students for college chemistry?" I answer by the epigram, "By training them for something else, namely: living in sympathetic relationship to modern life." If we can only bring our boys and girls to understand the every day applications of chemistry, they will have no trouble about entrance credits in chemistry. The problem is merely to establish a new point of view, one that will make us realize that chemistry is no longer a mystic art, but a practical agency which, aided by a sympathetic understanding on the part of the masses of the people, will bring us enlarged prosperity and a better civilization. I want to suggest a book which I think is a wonder at bringing people to see chemistry in its new role. I have in mind Slosson's "Creative Chemistry," which I referred to above. In the last chapter Dr. Slosson gives a splendid list of references —all of them books which bear out the theme of this paper, "Chemistry as a Means of Coordinating Life with a Scientific Age."

OIL FIELDS OF WEST VIRGINIA.

A new oil and gas map of West Virginia is the latest addition to the Geological Survey's series of State maps showing the oil and gas fields of the United States. On this map, which measures 33x37 inches, the oil fields are shown in green, the gas areas in red, the pipe lines and refineries in violet, and the cities, towns, streams, railroads, etc., in a subdued black. The scale of the map is 1:500,000, or about 8 miles to the inch.

One who glances at this map immediately realizes two important facts—that West Virginia leads the gas-producing States of the country in the volume of natural gas it produces, and that in this State, as in Pennsylvania, the eastern limit of gas production lies a few miles beyond the eastern limit of oil production.

The map may be obtained from the Director, U. S. Geological Survey, Department of the Interior, Washington, D. C., for 50 cents.

AN ANALYSIS OF CURRENT EXAMINATIONS IN HIGH SCHOOL BIOLOGY.

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The present study is a development of part of one made in connection with a course in educational psychology at the Summer School of New York University in 1922, and suggested by Dr. Daniel Starch, who taught that course. Other portions of the study will be published later: they deal with similar situations in high school chemistry.

In order to determine what mental functions are actually involved in the study of high school biology, recourse was had to the examination papers of the College Entrance Examination Board and of the Regents of New York State. After preliminary study of the papers, a pedago-psychological classification was decided upon, and the questions of a series of examinations from each source were studied for the distribution of the various kinds of mental work through them. The working hypothesis is that the requirements of meeting these examinations serve as norms for the actual instruction, *even in courses that are not avowedly given for that purpose.* The kinds of function involved in the answers to each question were determined from several sources: (1) The writer's introspective data; (2) the correct solutions as given in the "cram-books" for both sets of examinations, now to be had in New York; (3) information by teachers of the subject; (4) information from students whom the writer had in 1921 prepared for these examinations; (5) chance remarks of the writer's students, noted during instruction. It is altogether probable that the results from these joint sources give a reasonably high degree of accuracy.

Eleven groups of material were finally distinguished, and the earlier classifications of the questions gone over to verify and correct the allocation.

The method of scoring was the following: Each part of a question which could be counted separately for credit towards passing the examination was taken as a single question. The relative values given them in marking were disregarded; this was done because these values are not to be had for the Board examinations but only for the Regents' and because it was found that these would unduly weight the scoring towards emphasis upon memory-work. Inasmuch as such weightings as are given are not based upon any objective criteria, but purely upon the exam-

Nature of Questions.	Board: 1914	1915	1916	1917	1918	1919	1920	1921	Board: Total	Per cent	Regents: Jan. 1914	June 1915	Jan. 1916	June 1917	Jan. 1918	June 1919	Jan. 1920	June 1920	Jan. 1921	June 1921	Jan. 1922	June 1922	Regents: Total	Per cent	Regents and Board: Total	Per cent
A. Rote memory for names; terms; names of animals, plants, and parts	2	4	3	4	4	5	12	12	56	21.0	4	6	8	6	2	3	8	6	3	6	3	5	72	12.9	128	15.6
B. Rote memory for definitions	1	0	6	0	0	0	0	0	7	2.5	0	0	0	1	2	1	3	7	2	2	0	2	20	3.6	27	3.7
C. Questions that involve *skill* in drawing	1	0	0	0	2	1	2	1	7	2.5	1	1	0	1	1	1	0	1	1	0	1	1	9	1.5	16	2.0
D. Memory for morphological features	6	7	11	3	3	6	4	10	50	18.5	8	9	9	12	9	13	19	15	5	3	11	9	102	18.2	152	18.5
E. Questions requiring thought	0	0	0	1	0	0	0	1	2	1.0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.2	3	0.4
F. Memory for processes, functions and life-histories	8	12	3	11	8	12	11	8	71	30.0	12	10	12	6	14	17	13	14	14	15	17	11	155	27.8	226	28.7
G. Rote memory for laws and principles	0	0	0	0	1	0	1	0	2	1.0	0	0	0	0	0	0	1	1	0	0	0	1	3	0.5	5	0.6
H. Memory for laboratory procedure or experiments	0	0	0	0	0	0	0	0	0	0.0	3	1	4	2	3	2	2	2	5	3	4	2	33	5.9	33	4.0
I. Memory for economic and harmful or useful effects and features of plants and animals	1	3	3	11	4	9	10	11	52	19.5	12	6	2	8	11	13	17	8	5	8	9	2	101	18.0	153	18.5
J. Memory for substances contained in objects studied	4	1	0	0	0	0	1	0	6	2.0	2	6	7	1	3	4	2	6	1	1	1	3	37	6.6	43	5.2
K. Questions other than those listed above	0	0	1	0	1	0	0	3	5	2.0	0	2	2	4	3	1	2	0	1	3	3	4	25	4.8	30	3.7

ination-writers' subjective judgment of the importance and possibly the difficulty of each question, this procedure is the more reasonable. Each question as thus delimited was entered under *each* group to which it belonged. Some questions were thus entered two and three times, but not more than this. Random samples showed that this procedure did not serve to give undue weight to any one group or any set of groups, but that the relative proportions of the groups were not changed over one per cent for any set of three or more examinations.

The examinations tabulated were those of the Board from 1914 to 1921, inclusive, and those of the Regents from January, 1914, to June, 1922, taking alternate January and June examinations until January, 1920, and all examinations thereafter.

The classification and the distribution will be clear from the accompanying table.

Summary of Table:

	Board	Regents	Board and Regents
Whole number of questions	268	558	826
Whole number of questions that are memory-questions	254	523	777
Percent of memory questions	95.0	94.0	94.3
Number of questions that can be answered by purely verbal memory	204	421	625
Percent of verbal memory questions	76.2	75.6	75.8
Whole number of questions possibly involving observation at first-hand (Groups A, D, H, and J)	112	244	356
Percent of possible observation questions	41.8	43.7	43.1
Whole number of thought-questions	2	1	3
Percent of thought-questions	1.0	0.2	0.4

In the summary of the table, every effort has been made to err on the side of generosity towards other functions than memory. This has led to giving all questions that possibly might be answered as a result of observation by any student a place in the totals of observation-questions. Inasmuch as the memory questions total 94 per cent or more for Board, for Regents, and for both together, and the observation-questions total less than 44 per cent for these groups of examinations, it will be plain that there is considerable overlapping of the two. It will be familiar to every teacher of the subject that the bulk of these questions are actually answered by memory of either text-book diagrams, teachers' diagrams, or by means of verbal memory. The figures for verbal memory, over 75 per cent for each set of examinations, confirm this.

The result of the tabulation may be expressed in the following conclusions:

1. Rote memory for a particular group of facts is the outcome that is at present sought for in instruction in college-entrance biology.
2. Approximately three-fourths of this may be purely verbal memory.
3. The ability to apply this knowledge in problems involving thought is not today sought.
4. Such items as can be remembered by means of observation are in the main also such as can be learned from the text without any observation at all.
5. There has been no constant trend or change in the psychological requirements in biology despite the changes introduced in the subject-matter during the last eight years.
6. There is no evidence that the scientific attitude or any factors of it are today sought in college-entrance biology.
7. The variation from year to year in psychological functions required is very great within certain limits. It is great enough within the limits of the different kinds of memory to make the Board and Regents' examinations entirely inconstant as measures of pupils' achievements in biology.
8. As taught for college-entrance the only advantage that biology today possesses is that its subject-matter may have some utility. In other respects it is on a par with Latin, Greek, or French. In short, it fails utterly to possess any of the educational values claimed for science except insofar as the subject-matter may have usefulness.
9. Only 19.5 per cent at most of the subject-matter treated in the examinations (Group I) has definite and undoubted usefulness. The percentage of the remainder that is useful is thus far only to be decided by subjective judgment. The writer considers that another 10 per cent, making 29 per cent in all, is the probable maximum of this except for pre-medical and pre-dental students. For these another 10%, making 39% in all, may be useful.
10. The great fundamental interpretive principles of biology are entirely omitted in college-entrance teaching of the subject.

NEW YORK ENROLLMENT NEARLY A MILLION.

Part-time pupils in New York City have increased in number by 21,946 since September, 1921, according to the principal's reports. In the elementary school 94,640 pupils are on part time, and in the high schools 58,770. Two boroughs have decreased the number of part-time pupils in the elementary school, and one has been able to place all high-school pupils on a full-time schedule. The total registration for elementary schools is 829,462; for high schools, 100,623; and for all public schools in the city, 963,426.

NORMAL SCHOOL AIDS RURAL SCHOOL OFFICERS.

Rural school extension work has been established by the Kansas State Normal School at Emporia as part of its regular extention program. This school has long been known for its experimental work with education achievement tests. It appears possible that the new extension division for extending the consolidation movement will have at least an equal effect in extending the name and fame of the institution. This division places at the disposal of rural people and school officers the services of several instructors in the rural department, an abundance of informational literature, and the possibility of securing musical and other attractions from the school. A manufacturing company has donated the use of a model transportation trust so that speakers and entertainers may be conveyed from the institution to the rural districts without undue expenditure of time and money. The Emporia institution is setting a lively pace which other extension and rural departments may well look to for suggestions and leadership in promoting better rural schools.—[K. M. Cook.

THE STATUS OF GENERAL BIOLOGY IN HIGH SCHOOLS OF THE NORTH CENTRAL STATES.

By W. C. Reusser,

Oneida, Iowa.

The Problem.

The study was undertaken in the hope that information might be secured which would aid in the building of a better course of study in General Biology for high school students. Information was desired on three points: (1), on the general status of the subject in high schools, including the place of General Biology in the program of studies, length of the course, requirement for graduation from high school, basic texts used, character of laboratory work done, etc., (2), on the aims of General Biology teaching, and (3), on the parts or phases of the subject matter which should receive most emphasis.

The Method.

To secure the desired information a questionary was prepared which was divided into three general parts. Part one contained questions on the general status of the subject in high schools. The questions included are the following:

What is the high school enrollment?
How many semesters of General Biology are offered?
What year in the course is biology offered?
Is biology required for graduation from your Academic course?
Is biology required for graduation from your Science course?
What is the basic text used? Laboratory manual?
Number of experiments required?
Number of pupils studying biology?

Part two was made up of eight aims in teaching General Biology which were to be ranked in the order of their importance by biology teachers. The eight aims submitted are the following:

To train pupils to make accurate observations.
To train pupils to think clearly and to form logical conclusions based on facts.
To enrich the life of the pupil through the aesthetic appeal of plants and animals studied.
To develop interest in the life of the environment by giving first-hand information of plants and animals.
To broaden the pupil's knowledge of his own body through the study of the structure and function of other animals and plants.
To make the pupil a good citizen through his knowledge of good food, good health and good living conditions.
To show pupils by the adaptation of plants and animals how they can adapt themselves to varying conditions of life.
To show how biology has helped human progress and welfare.

Part three of the questionary contained five phases or units of the subject matter which were likewise to be ranked in the order of their importance by biology teachers, and two questions on

general treatment of the subject. The phases of subject-matter submitted are:

Structure and function of organisms.
Interrelation between organisms and groups of organisms.
Adaptation of organisms to their environment.
Classification of organisms.
Man's ability to control the habits and relationships of plants and animals to serve his own ends.

The two questions on general treatment are:

Check the division you think most important: Plant Biology, Animal Biology, Human Biology.
Would you treat these divisions separately?

In the spring of 1922 this questionary was sent to three hundred thirty-seven schools in ten states of the North Central Section. Of this number sixty-three per cent were returned of which fifty-eight per cent reported teaching General Biology.

The Data.

The states as well as the size of schools from which the questionaries reporting General Biology were received are given in Table I.

Table I.

States	Enrollments of schools 1000–2497	500–999	250–499	100–249	30–99	Totals
N. Dakota	0	1	0	1	2	4
S. Dakota	0	1	1	2	1	5
Nebraska	0	0	0	0	1	1
Minnesota	1	2	7	14	6	30
Iowa	6	2	6	14	15	43
Wisconsin	2	2	3	2	7	16
Michigan	0	0	3	4	0	7
Illinois	0	1	0	2	1	4
Indiana	0	2	0	0	1	3
Ohio	0	3	6	0	2	11
Totals	9	14	26	39	36	124

Some Findings of the Study.

1. Practically four-fifths of all the schools reporting offer two semesters of General Biology. It is interesting to note that there is a tendency to offer but one semester in the smaller schools. No school with an enrollment over 500 students offers one semester of the science while three of the schools with enrollments of 250-499 offer but one semester, of the 100-249 group, seven offer one semester and of the smallest group eleven offer one semester of biology. One explanation of this fact is to be found in the crowded curriculums and limited teaching force so often found in the small schools.

2. General Biology is quite generally placed in the second year of the regular four-year high school course. In the smaller schools there is a tendency to place it in the third and fourth

years of the high school course. In seventy-one schools with enrollments less than 250 students there are twelve which place biology exclusively in the third or fourth years, while not one of the forty-seven schools with enrollments over 250 students place this science in the last two years of the high school course.

3. General Biology is required for graduation from the academic course in about one-fourth (24.3 per cent) of the schools reporting. For graduation from the science course it is required in nearly one-half (46.6 per cent) of the schools reporting.

4 The three most generally used text books in biology are, Hunter's "Civic Biology," Smallwood Reveley and Bailey's "Biology for High Schools," and Gruenberg's "Elementary Biology."

5. More commonly used than any other method of laboratory procedure is that of giving directions by the teacher, either in oral or written form, from material previously selected from various sources. Of the laboratory manuals used, Gruenberg's "Exercises in Elementary Biology," and Hunter's "Problems in Civic Biology," seem to be preferred.

6. About one-third of the schools do not require a stated number of laboratory experiments throughout the course; laboratory work is done, however. Of the schools having a definite requirement, the number ranges from ten to over two hundred for the year.

7. Biology classes are about equally composed of boys and girls. The numbers in the classes are about equal to the numbers found in other optional classes.

8. The two most important aims of General Biology as decided by the teachers of the subject are the following:

To broaden the pupil's knowledge of his own body through the study of the structure and function of other animals and plants.

To make the pupil a good citizen through his knowledge of good food, good health and good living conditions.

The three aims which are next in importance and are of nearly equal value are the following:

To train pupils to make accurate observations.

To train pupils to think clearly and to form logical conclusions based on facts.

To develop interest in the life of the environment by giving first-hand information of plants and animals.

9. The phases or parts of the subject-matter of General Biology which should receive most emphasis according to the teachers of the subject are the following. They are practically equal in value.

Structure and function of organisms.
Interrelation between organisms and groups of organisms.
Adaptations of organisms to their environments.
Man's ability to control the habits and relationships of plants and animals to serve his own ends.

10. Human Biology is considered the most important general division of biology according to seventy per cent of the teachers of that subject. This is in accord with the aims which were ranked first.

11. As to the treatment of the main divisions of biology, namely, plant, animal and human biology, there is more division of opinion, forty per cent of the teachers would treat them as separate units while fifty-nine per cent would treat the divisions as one interrelated whole.

THE ORGANIZATION OF THE HIGH SCHOOL FIELD TRIP.[1]

By Miss Katherine Ulrich,

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Considering the status of geography in other secondary schools, we in the Oak Park High School consider ourselves especially fortunate because physical geography is one of the advanced sciences following a year of general science. Most of our pupils are Juniors and Seniors. We have seven periods per week throughout the year. This affords opportunity to organize and write reports of field trips, and to carry out projects, and do experimental work.

However, as in most places, the trips themselves must be taken on Saturdays before the opening of the football season and after school before the daylight saving season ends. Since we plan to take each class on at least five trips in addition to local work, it is apparent that most of our work the first semester is field work and related text and laboratory work.

To those not familiar with this region it may seem impossible to find much variety in a region of such slight relief. However, it is possible within a radius of twenty-five miles to find:

(1) Limestone and a coral island as evidence of occupation by the sea;
(2) Clay pits, ground and terminal moraine to prove the reality of the Ice Age;
(3) Shore lines—both eroding and depositing—of our lake and its ancestor, Lake Chicago;
(4) The Chicago Outlet;
(5) Rivers—young, mature, terraced and rejuvenated;
(6) Bogs in all stages of formation;

[1]Read before the Geography Section of the C. A. S. & M. T. at the Hyde Park High School, Chicago, December 1, 1922.

(7) Swamps—drained and undrained—are found near home, and
(8) Crossing the village of Oak Park is the Oak Park sand spit laid down, across Des Plaines Bay during the early stage of Lake Chicago, while
(9) The Des Plaines River has entrenched itself in the floor of this old bay in one place, and elsewhere is parading in stolen property;
(10) We are within fifty miles of the Indiana Sand Dunes—the finest in the world.

You note that it is not a matter of going to the few places we have but of selecting from an abundance those places that will function most vitally in the understanding of the environment, and that can be reached in the time available.

The organization of our field work *begins* in class periods, and *ends* in laboratory work, consisting of the making of illustrations, models, etc.

Preparation for the trips begins the first day of school when we advertise the trips as a necessary part of the work. The first year was more necessary—now pupils ask, "When do we go on the first trip?" The second day each class decides on a day per week for after-school trips; e. g., one class goes each Monday, another every Tuesday, and so on—and also on a Saturday for the trip to the Dunes.

Then follows more immediate preparation. We talk about the trip the week before we go, showing models and lantern slides, discussing in connection with text book work and in a general way: (1) why we are going, (2) what we will see, (3) how it compares with other places in the United States and in the rest of the world, and (4) what foreigners say of it. Many are astonished that Madam Curie wished above all else to see the "river that Chicagoans had made run backwards" and that a body of European ecologists, when listing places in the United States they most desired to visit, gave the Indiana Dunes second place.

Thus it will be seen that we use the inductive method *first*. But there is always plenty left for deductive work *during* the trip. Whenever I have tried to do *all* the work during the trip I have failed, and the questionnaire has proved that pupils considered it uninteresting and unpopular. Data recently collected prove it in regard to this year's Blue Island trip—yet Blue Island is full of geographic interest.

Transportation is a problem. At first every boy wishes to take his car, but when the disadvantages are explained they are easily persuaded to go on street cars and railroads. Of course, the ideal way would be to have a bus. Then instruction could

be given en route and we would get home earlier than 7:30 p. m. or 9:00 p. m. as is now often the case.

As you no doubt surmise, this late return interferes with home study, but pupils soon become accustomed to getting assignments a day ahead, especially when school or class spirit is appealed to. This year out of 132 pupils, there have been very few who offered field work as an excuse for a poor English or Latin lesson the next day. After some of the longest trips, we allowed the morning classes to use one geography period to study other lessons and while this was appreciated pupils did not consider that a precedent had been established.

I believe proper clothing has much to do with the success of a trip. Nothing could possibly do more to spoil a Dune trip than high-heeled pumps—yet I once saw a party so garbed. Pupils are advised to guard against sunburn, or if it is an after-school trip, to wear clothing that will not be ruined by weather or weeds. Occasionally someone will follow directions too closely and wear a shoe that needs repairing or is too short, or trousers that will not stand the test of a Dune trip. It is because of such experiences and not because of any forehandedness that my sewing kit accompanies us on all trips.

Food constitutes another problem. If a pupil becomes ill on a trip, he is a liability and must be looked after; if he is ill after he gets home his experience does not recommend geography to his friends, nor does it increase his love for it, and so we always suggest that a good night's rest, a hot breakfast, proper clothing, and a well-selected lunch are indispensable assets for a successful trip, and that inasmuch as this is true, each person is partly responsible for the success of the trip. The problem of ice cream and soft drinks along the way was solved by taking sandwiches and fruit on after-school trips.

Usually we each take from twenty to twenty-five pupils at one time, and, while it might be easy to take that number to a place and return them in safety, it is quite another problem to teach them something while they are there. I suppose more teachers object to field work because pupils may become unruly, or inattentive, or work independently, thus making it impossible to develop a lesson, than for all other reasons combined. And so there must be some system.

We count our pupils every time we get on or off a car. The signal system is adapted from that used by Dr. H. C. Cowles of the University of Chicago—viz., one whistle means *come;* two,

come quickly; three, *be quiet, get out notebooks.* En route one whistle means *look to the right;* two, *to the left,* etc. We have almost no trouble over conduct and this season there has been none. Usually an appeal to personal, school, civic pride before any trip is taken is enough to forestall any unpleasantness; but last year it became necessary to tell several boys that they would not be required to go on the trip the following week. This announcement was followed by an unusual amount of advertising for the Stony Island trip. Those boys begged with tears in their voices, but they remained at home. It happened that many fossils were found that day and the mosquitoes had not received advance information regarding our visit, and so the trip was considered unusually successful. Needless to say, those boys never caused any more annoyance on trips—nor did any others—and they were lively boys.

We always give details of the route and expect pupils to keep informed in regard to their whereabouts, physiographically speaking. As a vitalizing agent, we make use of the imagination, the spirit of discovery, and competition and the instinct of play. When we go to the Chicago outlet we try to imagine what sort of trip this would have been during Glenwood times, e. g., when we board the car on Chicago Avenue we are *off* the Oak Park Spit and consequently *in* the water. Presently we ride *on* it for a few blocks; then we are in the water again, and so on. Now, this spit is of slight relief and it takes good eyes to know when we are on the land and when we are swimming. We keep this up all the way. Not every boy or girl succeeds, but more do than if we employed the usual method.

My most successful after-school trip began after we boarded a car on which most of the passengers were prim old ladies. We were coming to the spit and one popular rogue of a football boy yelled out, "Oh, I say, fellows, look at that Oak Park Spit!" Whether he had anticipated the reaction, I cannot say, but he fully appreciated it, and played up to it. "There's some more spit," he added, and so on. We transferred to another car leaving those women horrified that a teacher would allow such language. However, something had been started. Not a boy but was on the lookout for something—he might not know what—but he was looking and because he was he saw things that otherwise would have been passed unnoticed. Moreover, because the experience was a matter of play, competition and discovery, and therefore pleasant, he would not only drive his

folks over this region but would watch for similar features elsewhere and report them in class. As one boy expressed it, "I used to think they were just hills. Now I worry over whether they are dunes or moraines." We have had many cases where our weekly trip determined the family's week end trip, and still more, where the pupil would give a report of what he had seen to his parents while eating a cold dinner at 9:00 p. m. Many times I have heard it said that parents object to field work, but at a recent meeting of the Parent-Teacher Association every parent who spoke to us had nothing but encouragement for what we are trying to accomplish.

The field trip is the place par excellence to use the play instinct. I see no reason why wisely directed play should not constitute an effective instrument of learning. Allow me to cite a few examples. After climbing over dunes, we arrive at the beach, hot, tired and thirsty. What is more natural than to have a well-digging contest? Of course, one well would suffice, but why overwork it? We give general directions only and let each fellow solve his own problems. If you think it is such an easy matter, just try digging one yourself. Some one's expression indicates difficulties. You suggest that while this is really play, every out-of-door lover needs to be able to solve just such problems as are here presented, and soon you have a row of wells that would delight the most fastidious. Some will continue this play until several types of wells have been mastered. Once Mr. Goodman, of Prairie Club fame, came along just at inspection time and sampled each well. That was a red letter day!

Most pupils wish to go wading or swimming, but before anyone goes in we have a family conference about attending dangers. This leads to questions concerning beach and bar formation, the angle of slope of bars, quick sand, wave action, ripple marks, undertow, under-currents, etc. Each person is made to feel that he is about to set out upon an important adventure that may lead to the discovery of exceptional phenomena, and then in they go, to commune with Father Neptune. We have had interesting maps and reports resulting from such play periods.

While we eat lunch some engage in a boat race. Of course, the boats are made of waxed paper and frequently never come in. But why? There are all sorts of things to be suggested. When one encourages a spirit of friendliness and comradeship and pupils feel you consider them as assistants and prospective scientists they go on all kinds of independent expeditions during their "rest" period.

Another way to use play is to have it help folks forget how tired they are. The most bedraggled, woe-begone looking crowd can be revived on the leeward slope of a moving dune. While watching the moving sand you are reminded of what the boys and girls (they must be included) did here last year—how someone vowed he could clear bottom in one jump, another found coasting delightful, and that even a ball game was staged. Soon you are holding all the valuables and the crowd is somewhere on that slope. Fatigue vanishes and after ten or fifteen minutes every one is so enthusiastic that it is safe to proceed with the trip. And so eventually you get them over all the dunes. Right here I wish to mention that it is much more difficult to conduct a party of girls than boys. Boys will go anywhere with you, whether there are girls along or not; but girls are not often good sports unless there are boys in the crowd. Two boys in a class of girls is enough to set the pace.

I do not wish to give the impression that this play business is the only lesson we offer. It is just the lubricating oil. There is the regular planned lesson when conditions are observed, questions are asked, notes taken and diagrams made. Yet pupils are urged to record in their reports everything that happened. While some system must be followed, we encourage the development of individuality and the expression of personality in reports. Pupils are much at sea to be given so much freedom, and come in after school for much aid and comfort, but after the first report they have the idea and enjoy the work much more than the old stereotyped questions.

Recently we asked pupils in all our classes to say what they thought of the trips. Here are some of the reasons why they enjoyed them:

"Helped conversationally."
"Help in class as much and sometimes more than the text."
"Saw places I wouldn't have gone to otherwise."
"Explained previously observed phenomena."
"Helped visualize objects."
"I learned directions."
"Will help in future travel."
"Made me want to be in the open more."
"Never knew there were such things in the neighborhood—thought they were thousands of miles away."
"Made me more observing."
"The fault at Stony Island helped explain the Niagara escarpment."
"Trains one's powers of noting important things."
"Made me want to preserve important geographic features."

The following are reasons some gave for not enjoying them:

"Takes too much time."
"Could learn more from text and lectures."

"Uninteresting and unnecessary."
"Folks at home had to wait dinner."
"Poor scenery at Stony Island."
"Enjoyed Sand Dunes only."
"Didn't learn anything on any of the trips."

While we all agree with Monsieur Feuillerat that pupils should be taught to observe and think and not merely to learn—that they should be given an education instead of being prepared for one—yet the great problem is how shall this be accomplished? My own idea is that well-conducted field work is a very important means toward this end, and I hope that our experience may be of some assistance to others.

WITHDRAWAL DEPENDS ON INDIVIDUAL, NOT COURSE.

More than twice as many pupils withdraw from technical courses in the high schools as from academic courses, according to a study of three high schools of Cincinnati. R. J. Condon, superintendent of schools, states that this large withdrawal is not due to lack of attractiveness in the practical work but to the fact that certain types of boys and girls select the more practical, scientific, and technical courses because they can not, or fear they can not, do the work of the more abstract general courses. These pupils would probably drop out before completing the course, no matter what group of subjects they chose.

STRINGENT LAWS MAKE VISUAL INSTRUCTION EXPENSIVE.

To make the presentation of educational motion pictures in schools less expensive, the Visual Education Association of America will request the legislatures of certain states to modify for schools the stringent regulations that are designed for commercial motion picture theaters. According to A. G. Balcom, assistant superintendent of schools in Newark, N. J., there is less danger of panic in a school than in a regular theater, because children are under control and because the operator is usually a teacher. New Jersey laws permit the showing of films of any kind, inflammable or noninflammable, without the necessity of having a booth and with any kind of projector, while New York laws place so many restrictions on the exhibition of motion pictures that only 10 per cent of the schools of New York City can afford to use films as a part of their teaching equipment.

To care for badly nourished children and enable them to do their school work properly, the School Children's Free Lunch Association cooperates with principals of ten New York City schools in feeding a thousand children. Most of the members of the association are parents of children in the schools.

CLASS-ROOM SAYINGS.

A question from Millikan and Gale:
Explain the use of the rider in weighing.
An answer from the Philippines:
In hyppodromes there is a fixed weight for jockeys that is a weight, which, like the ballast, can be controlled by the horse in his speed. This is the reason why a rider is weighed before taking part in a race.
What subject in Physics is it an example of?
This is an example of a subject in physics which is: Gravitation.

In the use of the inclined plane, it is found that the lifting force would be equal to the weight lifted, if it were not for friction.

A foot pound is the amount of heat required to raise one pound one foot.

Centrifugal force is the force of gravity.

Centrifugal force is the force that draws swiftly.

A foot pound is the amount of energy necessary to raise the temperature of one pound of water one degree Fahrenheit.

Centrifugal force is several forces pulling together.

Centrifugal force is the force that trys to fly off a turning wheel.

Just before a storm the moisture in the air condenses and when the moisture is given off the barometer is caused to fall.

Inertia is restfulness.

Centrifugal force is when any force is between the weight and the fulcrum.

THE OUTLOOK FOR GENERAL SCIENCE.

By Charles H. Lake,

First Assistant Superintendent, Cleveland Public Schools.

Recently a gentleman related to me a story concerning the school life of two members of his family. He stated that interest in science had been stultified in the case of one of his daughters by reason of the fact that she had been compelled to study and attempt to learn many things which made no appeal to her from the standpoint of her present needs and that they had not been presented in a way interesting enough to have any other appeal. For example, she had been asked to learn the laws governing the expansion of gases as the introductory lesson on the subject with the obvious result that she was lost in the maze of language which could have but little meaning for her.

With his other daughter, he had had quite a different experience. The teacher had started her in the subject of chemistry, with the problem of removing stains from clothing by the aid of the proper chemicals. The one girl started the subject by finding it thoroughly enjoyable, while the other just as thoroughly learned to hate it. What was wrong in this particular case? Certainly not the science. Assuming, then, that it was not the pupil, we have left for consideration only the method and the teacher—both closely related in our modern system of education.

Now the subject, Expansion of Gases, can be made as interesting as any fairy tale of literature, and certainly it is a topic of as great importance as that of removing stains from dresses, if only it be presented in as interesting a way. Nearly all of

the thousands of motor cars in use in the world are being driven by the force of expanding gases. How interesting such a subject may be made when so many people are driving their own motor cars, if each little particle of gas is considered as a rapidly moving projectile battering on the sides of the room in which it is enclosed, one side of which being free to move is forced out. If a pupil finally deduces certain generalizations that may be called laws, well and good, otherwise insofar as a first year course in science is concerned, the laws may well be left to themselves.

In spite of the rather strenuous time that general science has had in the last ten years, I am convinced that it has come to stay and that it will retain a place in our program of studies. However, it should not be retained unless it can be justified in results which are as demonstrable as those in the case of other high and junior high school subjects. It is rare that we remove a course from the secondary school curriculum. More often do we maintain courses long after they have proved failures. A merchant hastens to discontinue an unproductive line of goods. It is not usually so with high school courses of study. As school administrators, we have been anxious to show an opportunity for wide election in our program of studies, and as a result, courses have sometimes been retained long after their period of maximum usefulness. We shall be compelled to take stock from time to time and omit those courses that are not productive of desirable results.

The lack of agreement among educators as to what should be embodied in a course in General Science has probably constituted a case against it. This, however, need not be considered serious. The same thing has been true of every one of the courses which we now consider fundamental in our secondary school program. We have had much diversity of opinion on the question of what stress shall be placed on the different divisions of mathematics; on what stress shall be given to formal grammar as a part of the course in English. The social science courses are quite as devoid of uniformity as the courses in general science. Such a situation is, by no means, lacking in real advantages. The mere fact that educators are thinking about these courses is evidence that they realize the existence of a problem worth solving. When there is no problem, there is no thinking.

In the first place, we have had very few teachers of General

Science. There have been few places where training in the subject was possible. The teacher training institutions have had professors of Physics, Chemistry, Biology, and Physiography, but they have had no professors who were attempting to teach teachers to work in the field of General Science. The result has been the logical one to expect. The urgent demand for general science teachers has come from the field and the supply has been woefully inadequate. However, there are still many high school principals who think that any teacher can teach general science—just as they thought that any one could teach physical geography and botany. If the history teacher had an incomplete program, it was filled out with classes in ninth year science work, and the results were correspondingly poor.

A few teacher training institutions have realized the need of courses in this field, but the opportunities for the training of teachers of General Science are still far too few. The teacher who has gone to prepare herself to teach General Science, often has come back a better teacher of one of the sciences. Of course, this is good insofar as it goes, but she still has had little training in the development of a course of study in General Science and the method of presenting it.

The college professors of Science have been slow to recognize General Science as a need. Their work with the more advanced stages of well organized courses of specific sciences has made them hesitate to approve a course of more or less disassociated science. They are doubtless right from their standpoint, but there is another standpoint. Gradually we shall develop teachers who are trained to do this work and they will develop courses which are sound in pedagogy and content.

Public schools cannot do otherwise than to reflect to some extent the spirit of the times. The last several years have been years of quick changes. Methods and ideas have been superseded by others—usually, but not always for the better. In such times, education shares in the confusion.

Many reasons have been given for the introduction of courses in general science a few years ago. Not all of these reasons have been good ones, and I shall not attempt to catalog them here. It is sufficient to say that at the present time we have courses in General Science. Are these courses serving the best interests of the pupils who take them? Are they serving the interests of the pupils as well as any other courses for which

they may have been substituted? If a negative answer must be given to these questions, we should discard the study of General Science until such time as we may be able to develop courses which will stand such a test.

Assuming, however, that the answer to the last question is in the affirmative, the next question to be answered is—what changes should be made in our general science courses in order that they may serve better the needs and interests of the pupils who are to study them.

First, we must decide what pupils are to take these courses. The last few years have shown remarkable increases in the enrollment of grades seven to twelve inclusive. In Cleveland the increase in these grades since January, 1920, has been 10,771 pupils or 37.7 per cent, distributed as follows:

	7th	8th	9th	10th	11th	12th
January, 1920	9,241	7,448	5,150	3,217	1,962	1.523
September, 1922	10,953	9,112	8,457	5,344	3,218	2,227
Increase in Per cent	18.5%	22.3%	64.2%	66.1%	64.0%	46.3%

There has been a marked tendency for pupils to remain in school thus to some extent, minimizing the argument that these pupils should be given some work in Science in the eighth or the ninth years since so many of them drop out of school before they reach the upper years and have an opportunity to study the sciences which are usually placed later in the high school curriculum.

To my mind, if we are going to have courses in General Science, we must justify them on the basis of present needs of the pupils, considering both the habits of study which they may acquire and the residue of content which may remain. In other words, if the course in General Science cannot be justified as the best use that can be made of a certain portion of a pupil's time in the eighth or the ninth years, it should be omitted. I have very little sympathy now with the argument that the pupil should be given the work since he should have some science and since he only has one chance in four of remaining until he may get it later. I do not believe that we shall need to worry much about that sort of an argument, for in my opinion, General Science can be justified on the basis that nothing can be substituted for it which will be so valuable to the pupil (a) in teaching him the best methods of study, and (b) furnishing him with interesting and valuable content.

The assumption requires that we employ good methods and that we shall have adequate material. The method implies the

assurance of the presence in the class room of teachers who are trained to teach and who have enough knowledge of content to assist in the choice of material and the building of courses of study. The scientists, in their teaching of the sciences which usually come later in the curriculum, have almost without exception placed the values, first, on informational content, and second, on discipline and method of study. With the general science course in the eighth or ninth year, I would reverse the order and place the method of study as the value of first rank. This, by no means, need minimize the value of proper selection of informational content. The pupil should be introduced to the best methods of study; should be assisted and led to develop the scientific attitude toward problems and at the same time be given an opportunity to assimilate the most usable and pertinent scientific facts in the life about him. The method of study will be the most sought for product; the content a most valuable first by-product. This does not mean we shall pay less attention to the selection of material. It will be a very great waste if we do not select the most worth while problems for our pupil to work on. We must do this in order to place the proper emphasis on our first aim—that of developing in him correct methods of study—good habits of mind. We cannot get the best results either from the pupil or the teacher unless we have the most vital material.

Man, in his conquest of nature, or, if we would put it differently, in his efforts to establish a co-operative relationship with nature, has gained a vast amount of knowledge which has given him power, enlightenment, security, comfort and pleasure. This store of scientific knowledge has gained for man a progress for each generation which has been beyond the dreams of each preceding generation. The progress of the last century, due to Science, has been greater than the progress of all the preceding centuries. It has purified the health of body and mind. It has increased wealth through increased production. It has increased the comforts of our daily lives. It has given us new uses of power. It has increased our daily pleasures. It has raised new questions in the fields of ethics, which, if solved, will assist us in a better understanding of our moral obligations in the direction of our rights and duties. It is as much a part of our lives as social science, as language or government. In our present civilization, it is not enough that the specialist know science. The public must know it, and appreciate it to secure for itself the results of civilization.

If some science is to be taught so that certain desirable methods will carry over to other fields, the teacher must possess an adequate training in the method he hopes to inculcate. Much of the failure in General Science teaching has been due to lack of appreciation on the part of teachers, of the importance of method and to an inadequate discriminating knowledge of content. If the teacher is content to let the matter drop with the acquisition of a few facts by the students, the time will be mostly wasted. As soon as we have the teachers, the problem concerning the value of Science as a secondary school study will be solved to a large extent.

Let us assume that we have agreed that General Science will be placed on either the eighth or the ninth year of school work —junior or senior high school as the case may be. How shall we develop a course of study that will be best for the particular community in which we happen to be teaching?

If we are to reach any decision concerning the methods and materials of a course of study, we must reach a rather definite agreement on the subject of the ends which we hope to attain through their use.

For purposes of discussion, we can agree that we shall place these objectives in order of their importance as follows:

(1) Method of study—planned to develop:
  (a) Independence of thinking and acting;
  (b) The habit of accuracy and exactitude;
  (c) The habit of suspended judgment;
  (d) The habit of perseverance and work.
(2) Information content—presenting:
  (a) Science material which appeals to the student from the standpoint of present interests and needs (not necessarily vocational);
  (b) Material which is rich in general cultural values and opportunities;
  (c) Material, the character of which stimulates pupils to more purposeful activities;
  (d) Material which furnishes an opportunity to *develop* appreciation of the privileges, duties and responsibilities of life in this age of rapidly developing science.

In the sciences which usually come later in the high school curriculum, such as Chemistry and Physics, I would place informational content on a par with method, but I would not do so for the first course in Science which may come in the eighth or ninth year.

At all times in his school course, but particularly at this period of his training, am I anxious that my boy shall develop an independence in thinking which shall remain with him the remainder of his life. I care little what the teacher may believe concerning the tariff question or the tax question, if she provides

a good opportunity for him to get the facts on these questions and reach his own conclusion concerning his beliefs. Science, being a truly non-partisan subject, quite free in this modern age from such prejudices as result from being born a Democrat or a Republican, lends itself particularly well to teaching which should result in independence in thinking.

The study of Science also should develop the habit of accuracy and the habit of suspended judgment. With the proper stress placed on these phases of his work, the pupil will soon learn that guessing is untrustworthy and that there is a certain pleasure which comes from studying and working over a problem until he knows beyond any reasonable doubt that the statements he makes represent his best thought and judgment and express a sincere belief on his part which he is willing to defend. Such experience gives him confidence in his powers which will develop rapidly as the method of careful observation and reasoning to conclusions is practiced.

There is an intense satisfaction which comes from doing work resulting in some sort of worth while knowledge or achievement, that is difficult to explain, but it is none the less real. The individual who never experiences the joy arising from the realization of having worked and of having achieved something worth while is indeed an object for sympathy.

The great thing that each individual is seeking is Happiness, which comes to him in proportion to the degree to which he has developed a philosophy of life that is sound and which can be satisfied by the attainments of the individual through a proper exercise and use of his powers. *Perseverance* and *work* are essential to such a realization and our school room methods should provide ample opportunity for practice in them.

Do not get the idea that young people do not like to work. They do and in later years, as they refer to the teachers who have influenced them most, they will invariably place at the top of the list those teachers for whom they have worked hardest. It is time to emphasize the habit of work as one of the fundamental objectives of the public schools.

I have no sympathy with the idea that we must justify every part of a course of study by the measure of its utilitarian values. One of the fundamental characteristics of the human mind is that it desires to know things. We are innately curious. In this respect, we are very like our Simian ancestors. If the information we acquire has an immediate use of somewhat prac-

tical nature, well and good, but it does not necessarily have to have this appeal to make it interesting and worth while. We may well spend considerable time in education with the study of subjects which broaden our vision and extend our horizons even though the information gained never be put to a directly practical use. The only thing that is necessary to secure an interest for such material is that it be presented in such a way as to place the correct emphasis on the most fundamental of human experiences. This applies as well to the study of Science as to the study of History and English. There has probably been as much time wasted in the last few years in hunting for and teaching so-called practical problems as in any other way in which we waste time in education. Please do not understand that I am minimizing the value of problems in method. I know of no other device of modern education which has so many points of value. However, many teachers trained in other methods of teaching have tried to put all lessons into problem form with many resulting disappointments. Not all the work should be put in this form. If, in the beginning of a teacher's experimentation with problems, occasionally a good one can be presented, the results will be most encouraging.

Since curiosity, as a characteristic trait, is so firmly fixed as a part of our natures, we shall always want to know a great many things, therefore, we shall be compelled to teach some facts. The progress, however, which we shall hope to make, will depend not upon the facts, but upon the habits we develop in acquiring the facts and upon the use that is made of the facts. Most facts are of very little value except as they enable a few of the people of the world to reason from them to conclusions of value to the world. These people are the Lincoln's, the Roosevelt's, the Steinmetz's, the Edison's, the Ford's, the Lloyd George's and the Schwab's. We need many more of these people, so of course in our schools we should be placing the emphasis almost entirely on practice in the use of facts in developing the habit of reasoning through to a conclusion. Our instincts lead us to be curious as to what five plus five is today. We need that knowledge today and we can put it to good use. We may get a sense of satisfaction from knowing that five plus five was ten yesterday, but it is of infinitely more importance to know that it will be ten next week.

The fact that the science the pupil retains is a most valuable by-product and should be cared for accordingly, impresses upon

us the value of well selected material from the great mass of material which exists.

We say that the material should be selected from the standpoint of present interests. This does not mean that since the boy may be interested in radio sets at this time that this subject should be stressed to the exclusion of others. It simply means that the material should be selected with due regard to the contacts that Science is making with the social and economic world in which our pupil lives.

The fine discriminations in values of the life about us come only through knowledge—knowledge of the arts and sciences. We are so constituted that we do get a great deal of pleasure from just knowing things. We want to see and experience the appreciation which others of our race have experienced in the ages that have passed.

Therefore, we shall want to study the best in Art, Music, Science, Literature, and Government for their cultural value. All subjects are cultural in the degree to which they develop appreciation of the values of the life about us and discover for us the power to understand and enjoy the beauty about us. The study of Science properly conducted develops an appreciation of the service which it renders to humanity, an appreciation of the interdependence which exists in the social life about us, an appreciation of the slow but certain progress toward a better understanding of nature's plans, and an appreciation of the privileges and responsibilities involved in the life in which we live.

The material which we shall select for our course in first year Science, then, shall be determined by these questions:

1. Can it be presented so that it may be understood by pupils of the age in the group?
2. Does it permit of presentation in such a way as to bring out the best in methods of study for our pupils?
3. Does it touch the life interests of the pupil in such a way as to make it reasonably vital?
4. Does it have an appeal which can be justified from the standpoint of its cultural values?

When these questions can be answered in the affirmative, then there need be little doubt that the material chosen will be worth while. The report of the commission on the Reorganization of Science in Secondary Schools, published in 1920, gives an excellent list of suggestions including such topics as Combustion, Water, Air, Light, Work and Energy, Magnetism and Electricity, and Nature's Balance of Life.

In conclusion, it would seem that from the large amount of available material, the general science teachers of any particular community should select the material for their course of study, varying the selection with the community in such a way as to appeal as strongly as possible to the interests of the pupils. I do not believe that any one course is suitable for all communities. We can probably agree that there are certain fundamental topics which should be included in all courses such as the ones mentioned above. However, their treatment can be varied to relate them to the life of the community with no loss in basic content and great gain in interest.

The demand for teachers of general science should result in many more teachers taking up the work as their chosen field of teaching and in the development, on the part of teacher training institutions, of attractive courses in both content and methods. In my belief, the need for the subject of General Science exists and we are well on our way toward solutions of the problems which have arisen in the early years of its development.

TEACHERS RECRUITING.

At the close of the World War a good deal was said and written about teacher recruiting. But there is just as much need for it to-day as there was then. Educational surveys that have been made since the World War show that, as a whole, the teaching force is inadequately prepared, and this condition comes at a time in our country's history when well trained, experienced, and patriotic teachers are needed as much, if not more, than ever before. Would it not be well for high schools, colleges, and universities to induce their students to consider the advantages of the teaching profession? Should not sincere teachers pledge themseves to set forth on all occasions every possible reason why the teaching profession is attractive?

Every successful teacher knows that there are plenty of reasons why the teaching profession is attractive. Why not urge young people to consider these advantages? Here are some of them:

The teaching profession presents an unusual variety of interests. For actual classroom work there is the kindergarten, the various grades of the elementary school, the high school, and the college. Again one may choose to become a teacher of special subjects such as music, physical training, or household arts.

After a successful experience in classroom teaching there often comes the opportunity for supervisory and administrative positions. These are almost as varied as the classroom positions. Some of them are: Supervisor of elementary schools, of music, of penmanship, of manual training; director of playgrounds, of vocational guidance, of educational and intelligence tests; grade principal, county superintendent, and city superintendent.

The summer vacation offers a splendid opportunity for self-improvement through travel and through attendance at summer schools. It also offers opportunities to teach in summer schools, especially for those who hold administrative positions.

The sabbatical leave for study and travel, now granted by some city schools and by some colleges, is well worth considering when summing up the asets of the teaching profession.

Salaries of teachers are in no way commensurate with the time and money spent in preparation. Yet the outlook to-day is better than it ever has been. The public is beginning to realize that efficient teachers should be paid salaries that take into consideration the cost of preparation.

Best of all is the opportunity for a high type of service. A noted educator has well expressed the idea as follows: "The spirit of service must ever be the corner stone of the teaching craft. Our colleges and universities are teeming with young people just as eager to serve and sacrifice as were the college men and women of 1917 who volunteered by the thousands to serve their country at home and overseas. Could not the present college generation be made to appreciate the fact that the greatest service that can be rendered to the Nation is in guiding the intellects and the hearts of the 21,000,000 children in our public schools? They are the hope of America. In their intelligence, in their ideals, and in their citizenship lies the future of our Republic."

SETTING OFF 14,000,000 POUNDS OF DYNAMITE WITHOUT HURTING ANYONE.

Setting off a big charge of dynamite or blasting powder in a rock quarry is a job that the average person would rather leave to someone else. People, generally, have a whole lot of respect for high explosives. They realize that every ounce of the material carries certain death if it goes off at the wrong time.

Last year over 14,000,000 pounds of dynamite and powder were exploded in the rock quarries of the cement mills of this country without a single severe injury to any of the workmen.

The nature of cement manufacture demands the use of thousands of tons of rock. Naturally this rock must be dislodged by explosives. A charge sufficient for ordinary blasting work would be wasted in the quarries and it is a common occurrence for workmen to explode a charge of ten thousand pounds at a single shot. A charge of this size usually displaces about 50,000 tons of limestone. In some of the quarries single charges of eighty thousand pounds have been exploded.

The absence of serious accidents in handling this enormous amount of explosives is largely due to the work of the Bureau of Accident Prevention and Insurance of the Portland Cement Association. The sole function of this bureau is to look after the welfare of cement quarry and mill workmen—to help them themselves.

The work of the Bureau places it in personal touch with every man employed in the cement industry. Whenever an accident of any sort—no matter how slight—occurs in the mills or quarries, a report is made to the Bureau. There is no waiting for quarterly or annual reports. A study is immediately made of the causes of the individual accident, and the results of the investigation are brought to the attention of other workers in the industry. They are plainly shown how to avoid the conditions that caused that accident.

Naturally the prevention of accidents depends on the effort of the individual workman. To meet this situation every cement mill has an accident prevention organization. At various mills "No Accident Month" campaigns are periodically waged, when the men unite in trying to go through an entire month without a single injury. The success of this method is shown by the decreasing number of accidents throughout the industry. One plant employing about 350 men, was in continuous operation during the year 1921, with only four minor accidents.

In burning the raw material for making cement, intense heat is required —between 2500 and 3000 degrees Fahrenheit. Powdered coal is largely used in this operation, and as it explodes easily it is a dangerous material. Accidents from this source have been extremely few during the last few years, thanks to the vigilance of the accident prevention workers.

Accident insurance is carried for every workman employed by the cement industry. The yearly workmen's compensation premium for the cement companies amounts to approximately $750,000. This does not mean that this amount is paid for injuries, but that it is the sum paid by cement companies to insure the workmen against accidents.

The Portland Cement Association is an active member of the National Safety Council, an organization devoted to the education of the people in the cause of accident prevention.

PRODUCTION OF GYPSUM IN 1921.

According to conservative estimates made by the United States Geological Survey from the incomplete returns available April 1 the quantity of gypsum mined in the United States in 1921 was approximately 2,870,000 short tons, as compared with 3,129,142 tons in 1920. The combined value of the crude and calcined gypsum sold was approximately $20,820,000, as compared with $24,533,065 in 1920.

IRON ORE IN NORTH CAROLINA.

The continuous production of brown hematite (iron ore), in North Carolina during the last five years has attracted attention to that State as a possible source of an abundant supply of ore of that kind when the demand for it becomes greater. Since the beginning of 1917 about 126,000 tons of brown hematite has been produced in the State, a large part of it in Cherokee County.

Most of the deposits of brown ore in North Carolina are found in the valleys that lie between the mountain ranges in the western part of the State and on the Piedmont Plateau, in its central part. Some deposits are found in the Coastal Plain, but they are of little value. The largest deposits in the mountain district are in Cherokee, Madison, and McDowell counties. Those in the Piedmont region are in Catawba, Lincoln, and Gaston counties.

The origin and age of the deposits, the character of the ore, and other pertinent information are set forth in a report by W. S. Bayley, just published by the United States Geological Survey, as Bulletin 735-F.

SHOULD STUDY HIGH SCHOOLS' HOLDING POWER.

Need for a complete study to find the holding power of all high schools in New York State for a period of years is shown by the results of a limited study of that subject, according to a bulletin of the University of the State of New York. Pupils of the high-school graduating class of June, 1921, were studied in forty cities of the third class. Seventy per cent of the pupils who had entered the high school four years before were not graduated, some of these having dropped out of school and some having been retarded by failure at various points in the course. When this group of pupils was graduated from the elementary schools, in 1917, about 16 per cent of the graduates did not enter high school. Since such a large proportion of pupils in certain cities fail to take full advantage of the schools provided, the State Education Department feels that further information should be obtained regarding all the cities of the state. In the course of the complete study it should be possible to determine the influence of the different factors which tend to cause loss during the high-school period.

THE SOUTHERN CALIFORNIA SCIENCE AND MATHEMATICS ASSOCIATION.

Minutes of the General Meeting, March 31, 1922.

The Southern California Science and Mathematics Association held a short but interesting and well attended session at Lincoln High School, Los Angeles, on the evening of March 31, 1922.

The principal speaker for the evening, Professor Loye Miller, of the University of California, Southern Branch, was unable to attend, much to our regret. The Physics-Chemistry section drew the largest crowd with its talk and conference on "Recent Impetus in Radio" by Mr. Forbes Van Why of the Wireless Shop, Los Angeles. Other very interesting talks and conferences were conducted by Miss Myrtle Collier of the university of California, Southern Branch, and Miss Mary C. Meredith of Polytechnic High School, Los Angeles, in the mathematics and biology sections.

A group of general science teachers met with Miss Agnes Ralph of Owensmouth to discuss the advisability of organizing a general science section. It was the opinion of those present that the needs of general science teachers were already covered in the earth science, biology, mathematics, physics and chemistry sections and that the formation of another section at this time was unnecessary, though the subject would be taken up again any time if a group of general science teachers should signify their wish to have it discussed again.

Reading of the Secretary-Treasurer's report was postponed until the next general meeting.

GRACE M. R. ABBOTT,
Secretary-Treasurer.

Minutes of the General Meeting, December 20, 1922.

The fall general meeting of the Association was held as usual during the Los Angeles County Teacher's Institute, and was very well attended. The weather was of southern California's finest. The meeting place was Los Angeles Polytechnic High School. President Martin L. Fluckey presided.

The program consisted of a general business meeting and election of officers followed by section meetings with business and election of section officers, and was finished up as rapidly as possible so that all who cared to go might visit the Goodyear Tire and Rubber Co.'s plant; or hear the talk on Birdlife in Southern California given the biology section by Mr. Alfred Cookman of Los Angeles Polytechnic High School. There was a repetition of the Goodyear trip Friday afternoon, so that one might hear the very excellent description of our native birds on Thursday and learn much of the intricacies of tire manufacture on Friday.

Reading of the minutes of previous meetings and report of the Auditing Committee were postponed on account of the absence of the Secretary-Treasurer, Dr. L. C. Frost, Chairman of the Committee on Educational Films and Mr. C. W. Sandifur, Chairman of the Committee on Institute Programs, were not there to report for their committees. Miss Carobel Murphy reported that her committee had conferred with Mrs. Headlee of the Southwest Museum and that a report of this conference had appeared in the Los Angeles City School Journal, together with an invitation to all schools to make full use of the museum.

Dr. Leroy S. Weatherby gave a detailed explanation of the new plans for the American Chemical Society's contest, whereby the number on the various teams depends upon the number of students enrolled in

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chemistry classes at the different schools. The society will give to the winning students certificates of membership in the society, in addition to the cups awarded the winning schools.

A motion was passed to send a vote of thanks to California Institute of Technology for what they have given the teachers of southern California in the Friday afternoon and evening lectures.

It was voted that the chair appoint a Committee of Three to continue the work of last year's Program Committee, this committee to endeavor to secure speakers throughout the year in addition to Christmas time, and if possible to secure the recognition of attendance at such meetings in lieu of attendance at institute.

The report of the Nominating Committee for officers for 1923 was as follows:

For President: Dr. Leroy S. Weatherby of the University of Southern California.

For Vice-President: Miss Laura E. Liddle of Santa Monica High School.

For Secretary-Treasurer: Miss Grace M. R. Abbot of Venice High School.

The motion to adopt this report was carried unanimously, and these officers were declared elected for the coming year, 1923; after which the meeting adjourned.

GRACE M. R. ABBOTT,
Secretary-Treasurer.

At the Section meetings of the Southern California Science and Mathematics Association, the following officers were elected for 1923:

Mathematics Section: Chairman, Mr. W. A. Bartlett, Junior College, Pomona, Calif., Secretary, Mr. George I. Johnstone, Hollywood High School, Los Angeles, Calif.

Earth Science Section: Chairman, Mr. H. M. Werre, High School, Alhambra, Calif.; Secretary, Miss Bernice Ogden, Lincoln Junior High School, Santa Monica, Calif.

Biology Section: Chairman, Mr. Alfred Cookman, Polytechnic High School, Los Angeles, Calif.; Secretary, Miss Eunice Munson, Lincoln High School, Los Angeles, Calif.

Physics-Chemistry Section: Chairman, Miss Isabelle Willson, Manual Arts High School, Los Angeles, Calif.; Secretary, Mr. C. W. Gray, Hollywood High School, Los Angeles, Calif.

TEACHING THE PEOPLES OF THE EARTH

By Robt. M. Brown,
State Normal School, Providence, R. I.

One of the many things which the events of recent years have impressed upon us is that the teaching of the races of mankind has not kept pace with the advances in other lines of geographic endeavor. And now because the world at large is facing a new and more impressive program concerning the peoples of the earth, it is necessary for geography teachers everywhere not only to fill the gap which their own negligence has caused but also to catch the spirit of the present widespread attitudes towards other races and minority peoples.

It has always been the contention of the geographic that the teaching of geography presents a fair and unbiased study of peoples of the earth; and that a true teaching of geography will tend to the understanding of the races of men and will to a degree soften or even erase the feelings of race criticism which now endanger us. In place of ignorance and prejudice, geography fosters understanding and therefore respect and sympathy. It might be worth while therefore to review somewhat the features and lines of thought which have in times past been the universal characteristic in the teaching of the races of the earth. As a purely historical matter this would be of no value but as remnants of this earlier view still obtain, it is hoped teachers will catch the intent which lies at the foundation of a geographic presentation of distant peoples and face definitely and sternly in the right direction. The following propositions, stated somewhat didactically, perhaps, are worth our consideration.

1. IT IS NOT WISE AND IT IS NOT NECESSARY TO TEACH IN ELEMENTARY GEOGRAPHY THE CLASSIFICATION OF RACES.

Our older geographies introduced the classification of races as a paragraph near the beginning of the text. The children learned and recited by memory that peoples were divided into the Caucasian, Mongolian, African, Malayan and the American races: later a new pedagogy of words but not of subject matter introduced the words, "white, yellow, black, brown and red" for these. When this matter had been learned and recited, the matter usually ended. No particular use of this knowledge was made in the succeeding days and there appears to have been no call for the discussion of the subject at this stage of the child's learning. Therefore, apart from the very bad principle involved in the process, there was apt to result undesirable consequences inasmuch as the child was left to draw his own conclusions from insufficient evidence—an unsafe and questionable process—especially as in many environments such conclusions may be based on provincial rather than cosmopolitan ideas.

2. IT IS WELL TO AVOID THE TERMS, "CIVILIZED," "UNCIVILIZED," "SAVAGE," AND THE LIKE.

These terms come too glibly from the tongues of men when distant peoples are the subject of conversation. It is an easy thing, and one too often practised, to call ourselves civilized and all other peoples uncivilized. Frequently when people do this thing, underlying the whole matter is an ignorance of the ideals of the distant peoples. Far preferable to this is a classification similar to that used in Dryer's Economical Geography.

3. FASHIONS, AS A RULE, ARE NOT PROPER SUBJECTS FOR THE GEOGRAPHY LESSON.

Fashions are, of course, curious both at home and abroad; a study of them might be interesting but they are not the first things to be known concerning any people, rather they are the last. National ideals as expressed by the peoples and worked out in their dealings with men, in war and in trade, is the fundamental factor.

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SOLUTION OF PROBLEMS.

766. *Proposed by Norman Anning, Ann Arbor, Mich.*

The plan of the Bahai Temple in Wilmette, Ill., is a regular nonagon. If the length of a side is 70 feet, what is the greatest distance from a side at which a person can stand (outside the temple) and see just one side? Just two sides? Just three sides?

Solution by Lucile A. Mower, Indianapolis, Indiana.

(1) Only one side visible. $BX = 35$. $\angle XBY = 40°$. $XY = 35 \tan 40° = 29.37$.

(2) Only two sides visible. In $\triangle BCV$, $BC = 70$, $\angle BCV = 40°$, $\angle BVC = 30°$. $BV = 70 \sin 40°/\sin 30° = 89.99$.

(3) Only three sides visible. $CU = CY = 35 \sec 40°$. $XU = XC + CU = 35(1 + \sec 40°)$. $XZ = XU \cot 10° = 35(1 + \sec 40°) \cot 10° = 457.6$.

Also solved by *Albert J. Dow, Harvard School of Education; T. E. N. Eaton, Redlands, Calif.; J. F. Howard, San Antonio, Texas; H. Lazott, Worcester, Mass.;* and the following pupils of the *Brackenridge High School, San Antonio, Texas; James Combs, Hesiquio Gonzalez, May Garrett, Margaret Norton.*

767. *Proposed by James Singer, Cornell '26.*

Prove that cos 36° is a root of the equation $4x^3 + 2x^2 - 3x - 1 = 0$.

I. *Solution by A. J. Dow, Harvard Graduate School of Education.*

$\cos 108° + \cos 72° = 0$ or $\cos 3(36°) + \cos 2(36°) = 0$. Using the relations $\cos 3m = 4\cos^3 m - 3\cos m$ and $\cos 2m = 2\cos^2 m - 1$ we get $4\cos^3 36° - 3\cos 36° + 2\cos^2 36° - 1 = 0$ which proves that $\cos 36°$ is a root of the given equation.

II. *Solution by J. F. Howard, Brackenridge H. S., San Antonio, Texas.*

Substituting $\cos 36°$ for x in $4x^3 + 2x^2 - 3x - 1$, we get $4\cos^3 36 + 2\cos^2 36 - 3\cos 36 - 1$.

$$\begin{aligned} &= 2\cos 36(2\cos^2 36 - 1) + (2\cos^2 36° - 1) - \cos 36° \\ &= 2\cos 36 \cdot \cos 72° + \cos 72° - \cos 36° \\ &= \cos 108° + \cos 36° + \cos 72° - \cos 36° = 0. \end{aligned}$$

Hence $\cos 36°$ is a root of the equation.

Also solved by the following, who found the value of $\cos 36° = (1 + \sqrt{5})/4$ and substituted it in the given equation: *W. H. Carnahan, Washington, Ind.; T. E. N. Eaton; C. E. Githens, Supt. Schools, Wheeling,*

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768. *Proposed by F. A. Cadwell, St. Paul, Minn.*

Given $\triangle ABC$. *State in the fewest possible words* (two letters denoting a line to count as one word) how to find a point, P, on AC produced such that if a line be drawn through P parallel to BC and meeting AB produced in D, the $\triangle CPD$ will equal $\triangle ABC$ in area.

By A. J. Dow: (1) $AP = 2AC \sin 18°$. (2) Take AP the larger segment of AC divided into extreme and mean ratio; or (2¹): Take AP the larger segment of AC divided by golden section. (3) Make AP = the difference between the hypotenuse of a right triangle (having legs AC and ½AC) and ½AC.

By C. E. Githens: Draw $CH \perp AC$; CH = 2AC. Draw AH and produce to M; HM = AC; Bisect AM at N and make AP = AN.

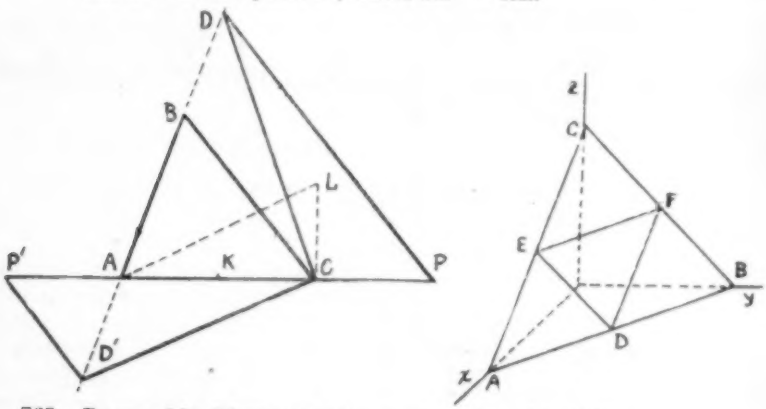
By J. F. Howard: Bisect AC at K. At C erect $\perp$ to AC and equalling CK. Draw AL. Make KP = AL.

By H. Lazott: AP = hypotenuse of right triangle, of legs AC and ½AC, added to or subtracted from ½AC.

By Nelson L. Roray, Metuchen, N. J.: Produce altitude AE to F; $EF = 2AE\cos 36°$. Draw PF11BC intersecting AC, produced, at P.

By the Proposer: Draw CE perpendicular to, and equal to half AC. On AC take AP equal to AE plus EC.

In A. J. Dow's solution (2), P is not on AC produced but on CA produced (P′ in the figure). The proofs of the various constructions are based on the equations: $KP^2 = AL^2 = AC^2 + CK^2$ since CK = CL. Then $AC^2 = KP^2 - CK^2 = (KP+CK)(KP-CK) = AP \times CP$ or $AP/AC = AC/CP$; also $AP/AC = PD/BC$ so that $AC \times BC = CP \times PD$ making $\triangle ABC = \triangle CPD$. The same equations may also be used for point P′, where KP′ = AL.



769 *Proposed by Morris Monsky, student Columbia College.*

Find the ratio of the number of acute triangles possible to the number of obtuse triangles; and show that the ratio is approximately 7 to 13.

As no solution of this problem has been received, the editor ventures the following solution based on the method used in problem 711, in January, 1922.

Call the three angles of the triangle, x, y, z, so that $x+y+z = 180$. Then if x, y, and z are regarded as the coordinates of a point in three dimensional space, the equation $x+y+z = 180$ represents a plane. Every point in the first octant (since x, y, $z > 0$) on this plane has 3 coordinates and these 3 coordinates (i.e., numbers) are possible choices for the angles of a triangle. In the figure, ABC represents the part of the plane which is in the first octant; the coordinates of A, B, and C are (180, 0, 0), (0, 180, 0), and (0, 0, 180); and the coordinates of D, E, and F are (90, 90, 0), (90, 0, 90), and (0, 90, 90) respectively. Hence the co-

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ordinates of any point within $\triangle DEF$ will all be less than 90, and these coordinates will be the possible choices of the angles of an acute triangle. At least one of the coordinates of any point not in $\triangle DEF$ will be greater than 90, and so will be possible choices for the angles of an obtuse triangle. Since the area of $\triangle DEF = \frac{1}{4}\triangle ABC$, there are *one-third* as many acute triangles as obtuse triangles. Is this solution correct?

770. *For high school pupils. Proposed by the Editor.*

Prove in as many ways as you can:

In $\triangle ABC$, the side AC is twice the side AB. Prove that $\angle B$ is greater than twice $\angle C$.

Frank Marshall, Dickinson H. S., Jersey City, gave three good proofs, and his is the only solution received. Considering that other harder problems have always elicited many solutions, the editor concludes from this meagre response that teachers do not find much time for "inequalities" in a geometry class. The editor himself has never spent more than two recitations on this subject and has considered only the theorem which proves "the greater side is opposite the greater angle, and conversely." To be sure, the theorems on inequalities are necessary when giving a complete proof of problems on loci and also for the theorem "the greater chord is nearer the center than the lesser chord," but there is not time to consider everything printed in a textbook.

PROBLEMS FOR SOLUTION.

781. *Proposed by I. N. Warner, State Normal School, Platteville, Wis.*

Which is more profitable and how much: for a farmer to sell his corn December 1 at 46c per bushel, or on May 1 at 52c per bushel, money being worth six per cent, and using the following table of shrinkage for ear corn from its harvesting to the first of each succeeding month:

Nov. 5.2% Dec. 6.9% Jan. 7.5% Feb. 7.8%
Mar. 9.7% Apr. 12.8% May 14.7%

782. *Proposed by C. E. Githens, Wheeling, W. Va.*

Find at least four of the smallest rational values of the unknowns in $x^2 - 6y^2 = 1$.

783. *Proposed by Burrell Morgan, Kroltitz, W. Va.*

The base of an isosceles trapezoid is 22 rods, the other three sides are all equal, and each diagonal is 25 rods. Find the lengths of the sides of the trapezoid, and derive a formula for the sides, s, when the base is b and the diagonals d.

784. *Proposed by Ben Shaw, Salida, Colo.*

Is the following construction for finding the side of an inscribed polygon of n sides accurate or approximate?

Divide a diameter AB into n equal parts. With A and B as centers and AB for a radius draw two arcs intersecting at M. Draw a line from M through the second (from A) division point of AB and extend it to intersect the circle again at C. Then AC is a side of the desired polygon.

785. *For high school students. Proposed by I. N. Warner, Platteville, Wis.*

In a 100-yard race A beats B by 8 yards, and C by 17 yards. What handicap in yards may B give C in a 100-yard race so as to run him an even finish?

PEOPLE WILL CHOOSE LOUISIANA'S SUPERINTENDENT.

Louisiana's State superintendent of education will hereafter be elected by popular vote instead of being appointed by the State Board of Education, according to an amendment to the State constitution passed at the last election. This constitution had been adopted in 1921, and the amendment is a reversion to the former practice.

New York City's junior high schools are increasing in number. Forty-one such schools now accommodate about 72,000 pupils.

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WANTED.

Standardized Tests in Physics—Where may they be obtained? The EDITOR received many requests for information.

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PRACTICAL PROBLEM FOR SOLUTION.

405. *Suggested by Science Question 403.*

A farmer has a wagon scale but loose weights have been lost so that he can weigh only up to 2,500 pounds.

He sells about a ton of hay, price $22.00 per ton, which is loaded on a wagon whose weight is 960 pounds.

There are at least two ways in which he can get the weight of the hay.

(a) Suggest the two methods. One is accurate, the other a close approximation. (Consider Jeff's method of weighing the cow.)

(b) What gain or loss do you estimate using Jeff's method? Who loses—the seller or the buyer?

For the best solution and discussion of problem 405, by a pupil *unaided*, the Editor offers a one-dollar bill.

406. *Proposed by R. M. Wood, Selma, Ala.*

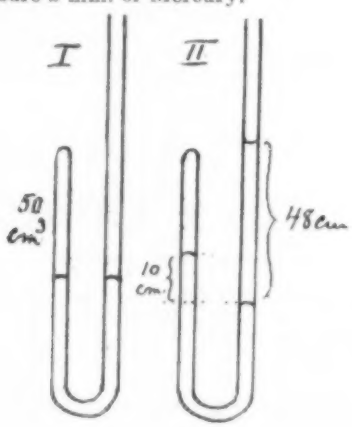
A man weighs 100 pounds and attempts to lift his own weight by means of a frictionless pulley attached to an overhead beam. What pull in pounds must the man exert in order to lift his own weight?

SOLUTIONS AND ANSWERS.

400. *Student Examinations—Problems in Physics, April, 1922. Submitted by John Lundberg, Göteborg, Sweden.*

(The questions were published in SCHOOL SCIENCE AND MATHEMATICS in December, 1922, page 886. On account of their length, *the questions are* not repeated here.) *Solutions by Mr. Lundberg.*

1. Call the pressure x mm. of Mercury.



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$$50\times760 = 45[x-100+(480/13.6)]$$
$$x = 909.1.$$

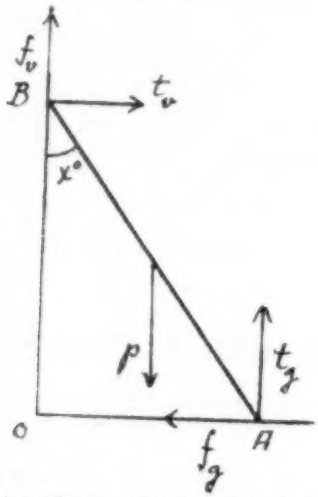
Hence the pressure is 909.1 mm. of mercury.

2. Call the angle x degrees.

Call the weight of the stick p, the pressures against the wall and floor t_v and t_g, the frictional forces f_v and f_g, then

$$f_v+t_g = p \quad (1), \quad \text{and } t_v = f_g \quad (2).$$

Call the length of the stick a and take B as the center of moments. Then,



$$f_g\times OB+p\times OA/2 = t_g\times OA,$$

or

$$c_g\cdot t_g\cdot a\cdot\cos x+(p\cdot a\cdot\sin x/2) = t_g\cdot a\cdot\sin x \quad (3)$$

because

$$f_v = c_v t_v, \text{ and } f_g = c_g\cdot t_g, \text{ from (1);}$$
$$p = c_v t_v+t_g = c_v c_g t_g+t_g = t_g(c_v c_g+1)$$

Then from (3)

$$c_g\cdot t_g\cdot\cos x+(\sin x/2)\cdot t_g(c_v\cdot c_g+1) = t_g\cdot\sin x;$$

After division by $\cos x$,

$$\tan x = (2c_g/1-c_v c_g).$$

Hence, the angle must be such that the tangent is $(2c_g/1-c_v c)$, *answer*.

3. The volume of the brass weight is (40/8.3)cc. in first case; and (40.333/8.3)cc. in the second case.

Take the weight of the two glass balls in vacuum as p grams, and of 1cc. of air at 0°, 760mm. mercury as x grams.

Then, in the first case,

$$p-300\times0.001213 = 40-(40/8.3)\times0.001213$$

and in the second case,

$$p-300x = 40.333-(40.333/8.3)x.$$

Subtract the first from the second,

$$300(0.001213-x) = 0.333+(40\times0.001213-40.333x)/8.3$$

Hence, $x = 0.000084$gm.

Then, 1 liter of oxygen weighs 0.085 grams.

4. The effect $= 220\times4.5$ watts $= 0.24\times220\times4.5$gm. col. per sec.

Then the energy developed in one hour $=$

$$3600\times0.24\times220\times4.5 \text{ gram-calories.}$$

Assume that x per cent of this energy is used,

then

$$(x/100)\times3600\times0.24\times220\times4.5 = 1100\times.621$$
$$x = 79.9 \text{ per cent, answer.}$$

(Answers to 5, 6, and 7 will be published in April.).

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The apparatus consists of an aluminum disk mounted on a vertical spindle, and a vertical support upon which are fixed two pulleys. A mass is suspended by means of a cord which passes over the upper pulley and under the lower one, and is wound several times around a wooden spool on the verticle spindle, so that when the mass drops, it sets the disk in rotation. The metal bar whose moment of inertia is to be found is placed on the disk and held in positiong by projecting pins which fit into holes in the disk. The disk is released by tilting a small lever which catches on a projecting pin on the wooden spool. A small adjustable platform on the upright support serves to locate the height to which the mass has dropped after falling a given number of seconds. Complete with rectangular steel bar and one hook weight 45 grams and one hook weight 100 grams. Price on application.

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ANNUAL REPORT OF THE CARNEGIE CORPORATION.

A remarkable group of varied activities, together with gifts during the past eleven years of nearly fifty-eight millions of dollars, is disclosed in the report of the President of the Carnegie Corporation made public today.

The major interests at present receiving their support wholly or largely from this corporation are the Institute of Economics in Washington, an agency for analyzing and publishing economic facts in popular form; the Food Research Institute at Leland Stanford University, a scientific extension of studies in the production and distribution of foods begun by Mr. Hoover during the war; the National Research Council in Washington, an organization that aims to focus and promote all sorts of scientific research in America; the Potter Metabolic Laboratory at Santa Barbara, California, where Insulin, the recently discovered specific for diabetes, is being manufactured and perfected; the American School of Classical Studies at Athens, for which the corporation is paying the cost of a building to house a notable library recently acquired by the school; and comprehensive investigations into the fundamentals of unemployment and into the means of improvement of the law.

A total of $5,254,000 has been paid to beneficiaries during the year ended September 30, 1922, of which $2,578,000 went to colleges and universities. Of nearly $58,000,000 expended during the eleven years of the corporation's existence, $23,415,000 has been given to four Carnegie institutions: the institute at Pittsburgh, the foundation in New York, and the institution and the Peace Endowment in Washington. In addition to $30,000,000 granted by Mr. Carnegie personally for public library buildings, $12,292,000 has been devoted by the corporation to the same purpose. Schools and colleges have received $9,276,000; medical and health education, $3,266,000; and scientific research, $1,511,000, chiefly within the past four years.

The report explains the policy of the corporation in discontinuing its gifts of libraries; and in a discussion of the "Science of Giving," the difficulties of making wise public benefactions will come as a surprise to many readers. It is of especial interest to note that the Board of Trustees, which includes as *ex officio* members the heads of the six important Carnegie organizations, is to be enlarged from ten to fifteen members.

The assets of the corporation amount to $130,000,000, which will be increased by about $10,000,000 on the final settlement of Mr. Carnegie's estate.

BOOK REVIEWS.

Exercises in Plane Geometry, by Murray J. Leventhal, M. A., Formerly Examiner in Mathematics, The University of the State of New York, and Joseph P. McCormack, M. A., Instructor of Mathematics, Stuyvesant High School, New York City. Pages 117, 13x19 cm. Paper covered. 1922. Globe Book Company, N. Y.

Over eight hundred selected exercises, classified so that they can be used with any textbook, are contained in this book which is well printed and arranged. Each group of exercises has been graded so as to encourage original thinking and to develop power to solve the more difficult ones. They include theorems to be demonstrated, numerical exercises, and practical problems. Teachers who do not wish to use a textbook will find this book very satisfactory for the purpose.

H. E. C.

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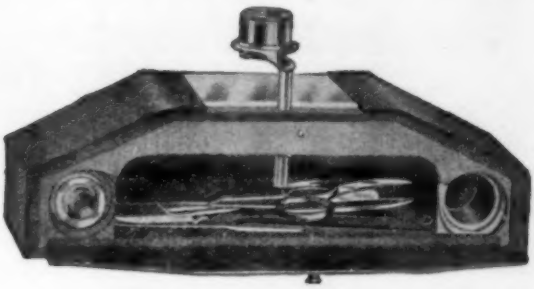

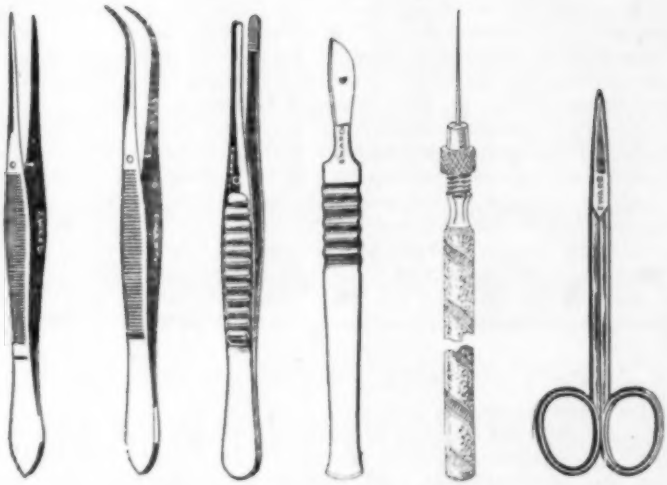

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Exercise Book in Algebra, A Revision of McCurdy's Exercise Book in Algebra, by Oswald Tower, Instructor in Mathematics, Phillips Academy, Andover, Mass. Pages v+180. 12x18 cm. 1922. D. C. Heath & Co., New York.

The teachers who for many years have been using McCurdy's exercise book will welcome this revision, since it meets the essential conditions of changes in school courses and college entrance requirements. The exercises which were too difficult have been omitted. Many exercises and problems and new chapters on theory of quadratic equations, graphs, logarithms, and numerical trigonometry have been added, making it one of the best exercise books in algebra.

H. E. C.

A Course in Analytic Geometry, by Paul P. Boyd, M. A., Ph. D., Head of Department of Mathematics, J. Morton Dairs, A. M., Professor of Mathematics, and Elijah L. Rees, C. E., A. M., Associate Professor of Mathematics, University of Kentucky. Pages x+252. 14x20 cm. Price $2.40. 1922. D. Van Nostrand Company, N. Y.

In this course the two fundamental problems, to find the locus of an equation and the equation of a locus are given due prominence and made the basis for arrangement of the work in both plane and solid analytics. The function concept is emphasized by classifying curves according to the character of the function involved rather than the degree of the equation. Though the derivative is used to find the turning points of curves, it is not used in the chapter on tangents and normals. This book will be appreciated by teachers who wish to emphasize the theoretical side of the subject in preparing students for advanced work in mathematics.

H. E. C.

Otis Correlation Chart, by Arthur S. Otis, Ph. D., World Book Company, Yonkers-on-Hudson, N. Y.

The purpose of this chart is to make the calculation of a coefficient of correlation as simple as possible so that it can be made without instruction by one who has never used any correlation formula before and so that a practiced user can find a coefficient by it with the least expenditure of time and effort. The chart is put up in packages of twenty-five, containing one direction sheet at $1.25 net per package.

H. E. C.

Biology. Globe Outline Series, by Charles Gramet, B. S. Instructor in biology, Stuyvesant High School, New York City. Fourth Ed. revised. Size 15x22 cm. Pages 112, illustrated. Paper covers. Published by the Globe Book Company, New York.

This book is intended to be used as a review of the subject of biology as usually given in elementary courses. It consists of a series of outline lessons, each including the purpose and conclusions reached by the lesson and a concise statement of directions for work to be done, or observations to be made. Definitions are given freely and many of the lessons are illustrated. A series of review questions is appended to each chapter and sample examination questions are found at the end of the book. The outline covers the usual course as given in the State of New York. It includes lessons on the structure, composition and properties of living things, on plants and animals and finally on sanitation and physiology of man. The treatment is conventional throughout and the presentation unusually clear and concise. No doubt the book will prove useful for those needing a review of the subject.

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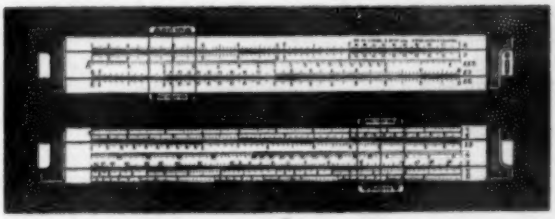
The Slide Rule in Trigonometry



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The Invertebrate Course in the Marine Biological Laboratory. A contribution to the technique of teaching zoology. By W. C. Allee, Marine Biological Laboratory, Woods Hole. Paper covers. Size 8 vo. Pages 32. Reprinted from the Biological Bulletin. vol. xlii, No. 3, March, 1922.

This is an interesting pamphlet describing the methods used in the invertebrate course at the Marine Biological Laboratory. The author devotes several pages to the history of the development of the course since its inception in 1888 and a statement or description of the methods used at the present time. The work as given now is the result of experience—a gradual evolution toward more study of the living individual and less of preserved specimens. The remainder of the paper is given to a statement of the work with the different groups of animals. In closing, a sample list of animals seen and collected during a single excursion, numbering 126 species, as posted by the recorder at the close of the excursion by the recorder.

W. W.

Entomology with special reference to *its Ecological Aspects, by Justus Watson Folsom, Sc D.* (Harvard), Assistant Professor of Entomology at the University of Illinois. Third revised edition with 5 plates and 308 text-figures. Pages vii+502. Size 15x22 cm. P. Blakiston's Sons & Co., Philadelphia, 1922.

This title above somewhat belies the author's statement of purpose in his preface, which stresses the *biological* treatment of entomology. However, in this edition the author has added a chapter of 62 pages on insect ecology, with the "expert advice" of Professor V. E. Shelford in its composition. The economic side of entomology is also well taken care of, as well as the ecological and the biological.

The author has not attempted to give the systematic view much attention since this side of entomology is well cared for in several standard texts. Professor Folsom has done a good service to students and readers, for these aspects of entomology had not heretofore been brought together. We shall not go into detail as to the merits of the book as they are well-known and the present writer reviewed an earlier edition for this *Journal*. The thoroughness of the readings and research in the preparation of the book may be understood when it is known that 48 pages of references are listed at the end of the book under appropriate divisions of the text. This, of course, makes the book especially valuable to the research student. It cannot be emphasized too strongly that this book should be in the possession of every teacher of biology who has any aspiration to know his subject.

W. W.

Zoology, a text book for Universities, Colleges and Normal Schools, by Thomas Walton Galloway, Ph. D., Litt. D. Associate Director Educational Activities, American Social Hygiene Association, New York, and Paul S. Welch, Co-reviser, Associate Professor of Zoology. University of Michigan. Fourth edition, revised, with 255 illustrations. Pages xv+558. Size 15x22 cm. P. Blakiston's Sons and Co. 1922.

This is a well-known text revised to "record and interpret such progress in the *science* as bears most directly upon the instruction of beginners." A former edition was reviewed in this *Journal* when it appeared. All who know Professor Galloway will also know that anything he undertakes is done with thoroughness and painstaking care. The author has had a purpose in mind and has held to this with great fidelity. Extraneous matter has been vigorously excluded. The book is for the beginner, and has a plan which is easy to follow. We have no doubt it is successful when put to the test of actual use in college classes.

We can unreservedly recommend it to those zoology teachers in high schools who wish a concise, up-to-date zoology text for reference in planning their work.

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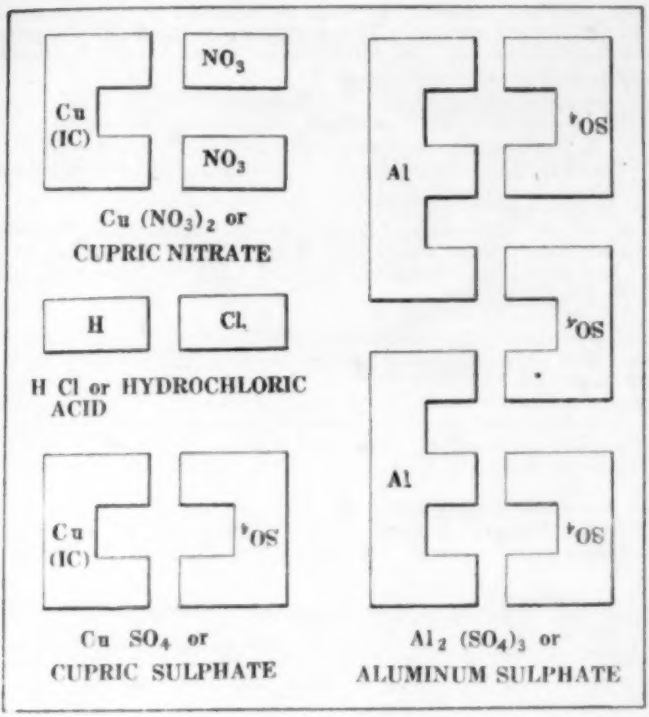

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DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March and November issues of this Journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. This is extremely valuable information to all progressive teachers. Is your society listed here? Names are dropped when they become one year old.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

(*36th Annual Meeting*, Cincinnati, Ohio, December, 1923.)

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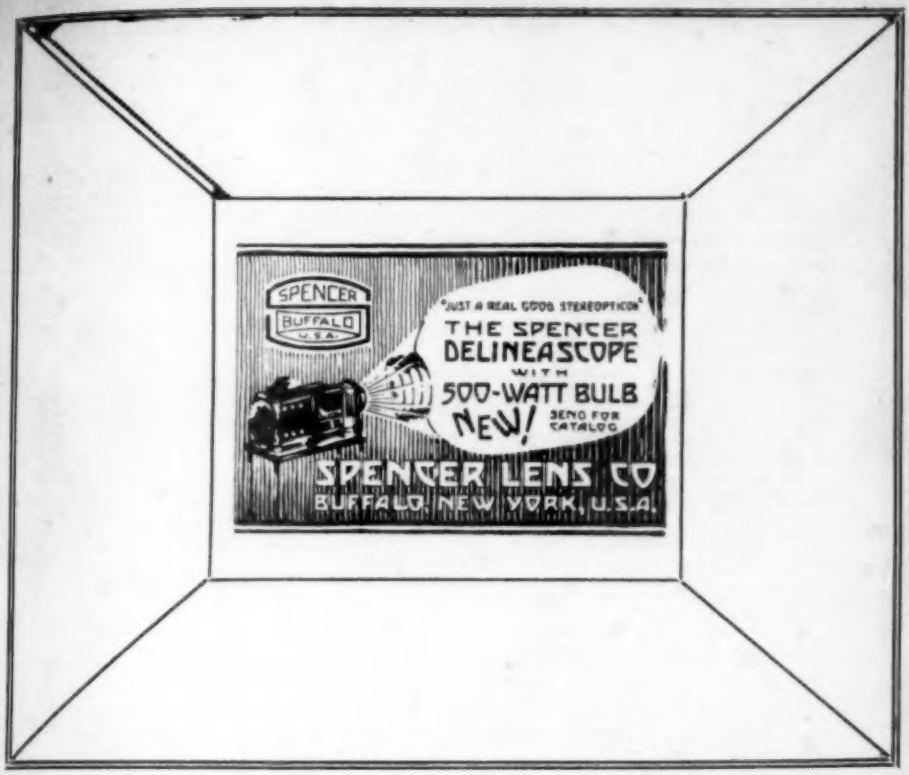

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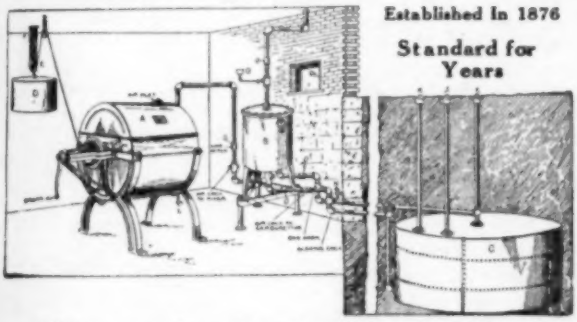

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